Instruction Handbook for....

G-G-110

AIL TYPE 125

POWER SIGNAL SOURCE

December 1966

WRIGHT ENGINEERING
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CUTLER-HAMMER

AIRBORNE INSTRUMENTS LABORATORY
DEER PARK, LONG ISLAND, NEW YORK 11729

CONTROL AIL DIVISION

Instruction Handbook for

75

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WARRANTY

Except for tubes and fuses which carry no warranty, Cutler-Hammer, in connection with the equipment sold, agrees to correct any defect in workmanship or material which may develop during the period of 1 year from the date of shipment under proper or normal use, and not in excess of the original manufacturer's life expectancy ratings. Cutler-Hammer shall have the option to repair or replace, FOB point of shipment, the defective part or parts. In any case, such correction shall constitute a fulfilment of all Cutler-Hammer liabilities in respect to said apparatus.

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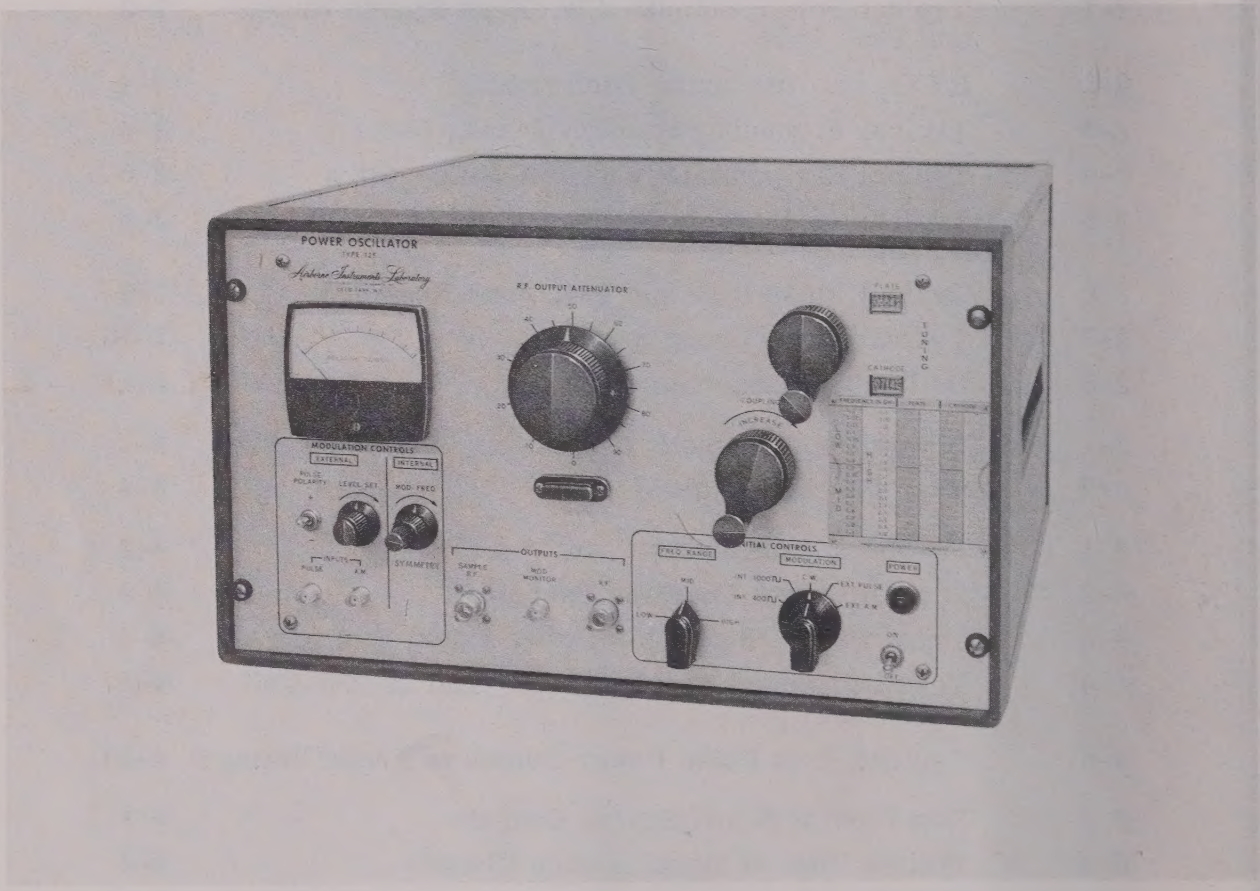


FIGURE 1-1. FRONTISPIECE, TYPE 125, POWER SIGNAL SOURCE

SECTION 1
GENERAL DESCRIPTION

The Type 125 Power Signal Source (Figure 1-1) is a versatile source of RF power. It provides exceptionally stable and spectrally pure signals at all frequencies from 0.2 to 3.0 GHz in three broad ranges; its power output is continuously variable from less than 50 microwatts to more than 50 watts, and the output is flat to within ± 1 db over most of its three ranges. An internal multivibrator permits 100-percent square-wave modulation of the RF oscillator at either 400- or 1000 Hz. An external generator can be used to 100-percent pulse-modulate the RF oscillator at any pulse width from 0.5 to 25 microseconds and at a pulse repetition frequency commensurate with a maximum duty cycle of 5 percent; or to 100-percent square-wave modulate the RF oscillator at any frequency from 300 Hz to 10 kHz.

SECTION 2
SPECIFICATIONS

This section contains tabular and graphic data pertinent to the performance of the Power Signal Source.

PERFORMANCE

Band	Frequency Range (GHz)	Power Output (Figure 2-1) (watts) (min)	Typical Frequency Resettability (percent)
LOW	0.2 to 0.5	50	±0.02
	0.5 to 0.6	35	±0.03
MID	0.3 to 1.0	50	±0.04
HIGH	0.9 to 2.0	25	±0.08
	2.0 to 2.6	10	±0.15
	2.6 to 3.0	5	±0.25

FREQUENCY ACCURACY

Front panel counter settings are accurate to ±1 percent for all modulation and power output settings. Typical accuracies are:

Maximum CW power output	±0.25 percent
Maximum square-wave, external pulse, and external AM power output	±0.5 percent

Power output adjustments will detune the Signal Source frequency less than ±0.25 percent, typically.

Replacement of the RF tube will shift the frequency less than ±0.25 percent, typically.

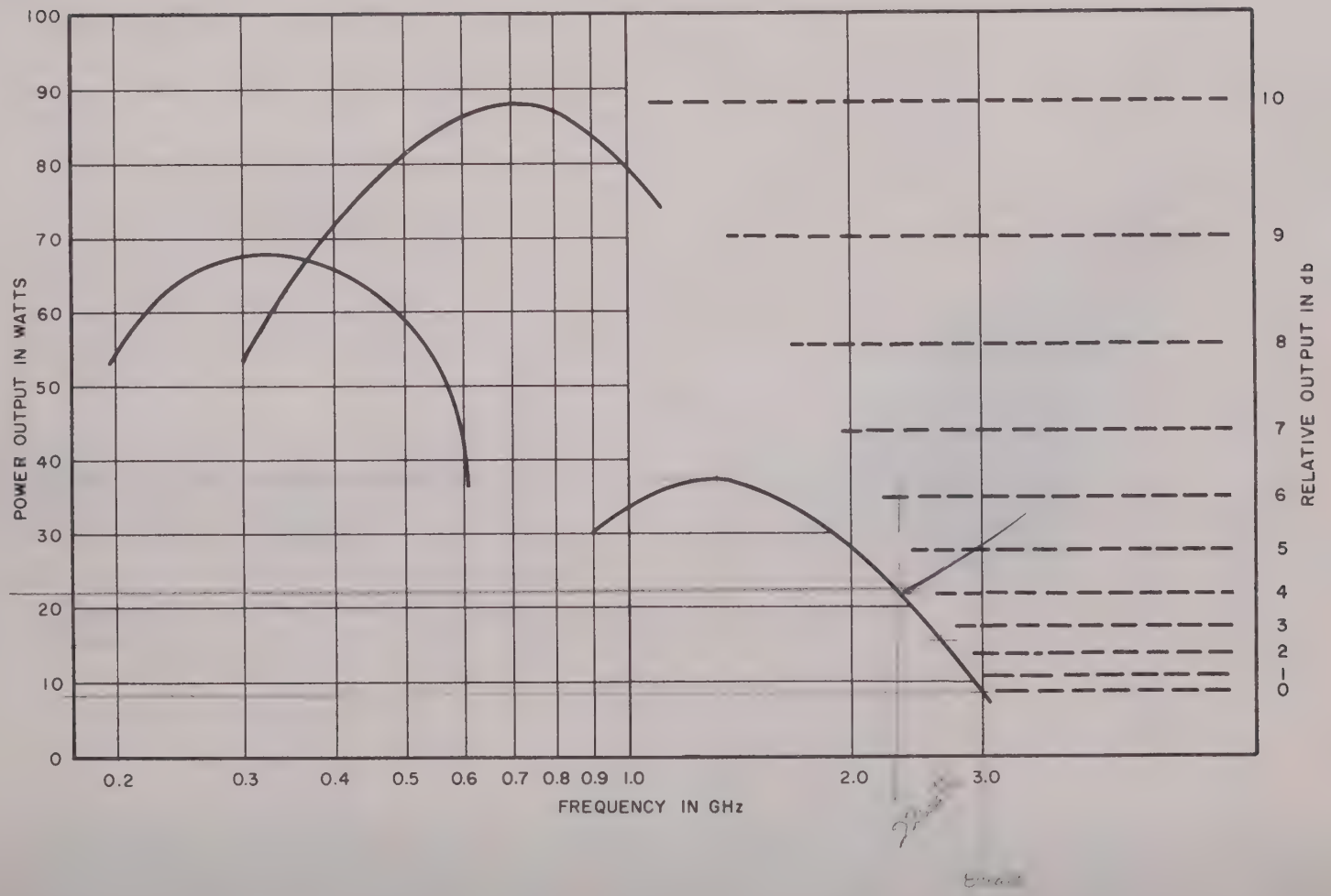


FIGURE 2-1. TYPICAL POWER OUTPUT - CW, PEAK SQUARE WAVE, AND PEAK PULSE

POWER ADJUSTMENT

RF Attenuation Range (variable) (Figure 2-2)	33 db (minimum)
RF Sample Output (fixed)	30 ±3 db below RF output
Total Power Output Variation Available	60 db (minimum)

STABILITY

For constant load, less than ±1 volt line-voltage variation, less than ±5°F ambient temperature variation, and after a 2-hour warmup period at the desired power output, typical stabilities are:

Power Output	±0.05 db/hour
Frequency	
RF (Figure 2-3)	±40 ppm/hour and ±20 ppm/10 minutes
Internal Modulation Frequency	±0.25 percent/hour

SPECTRAL PURITY

At maximum CW power, typical specifications are:

Residual AM	<2 percent
Residual FM	<0.005 percent
Harmonics (Figure 2-4)	
Second	>40 db down from fundamental
Third	>46 db down from fundamental

LEAKAGE

Signal-to-leakage ratio is typically greater than 60 db down at all frequencies and power outputs.

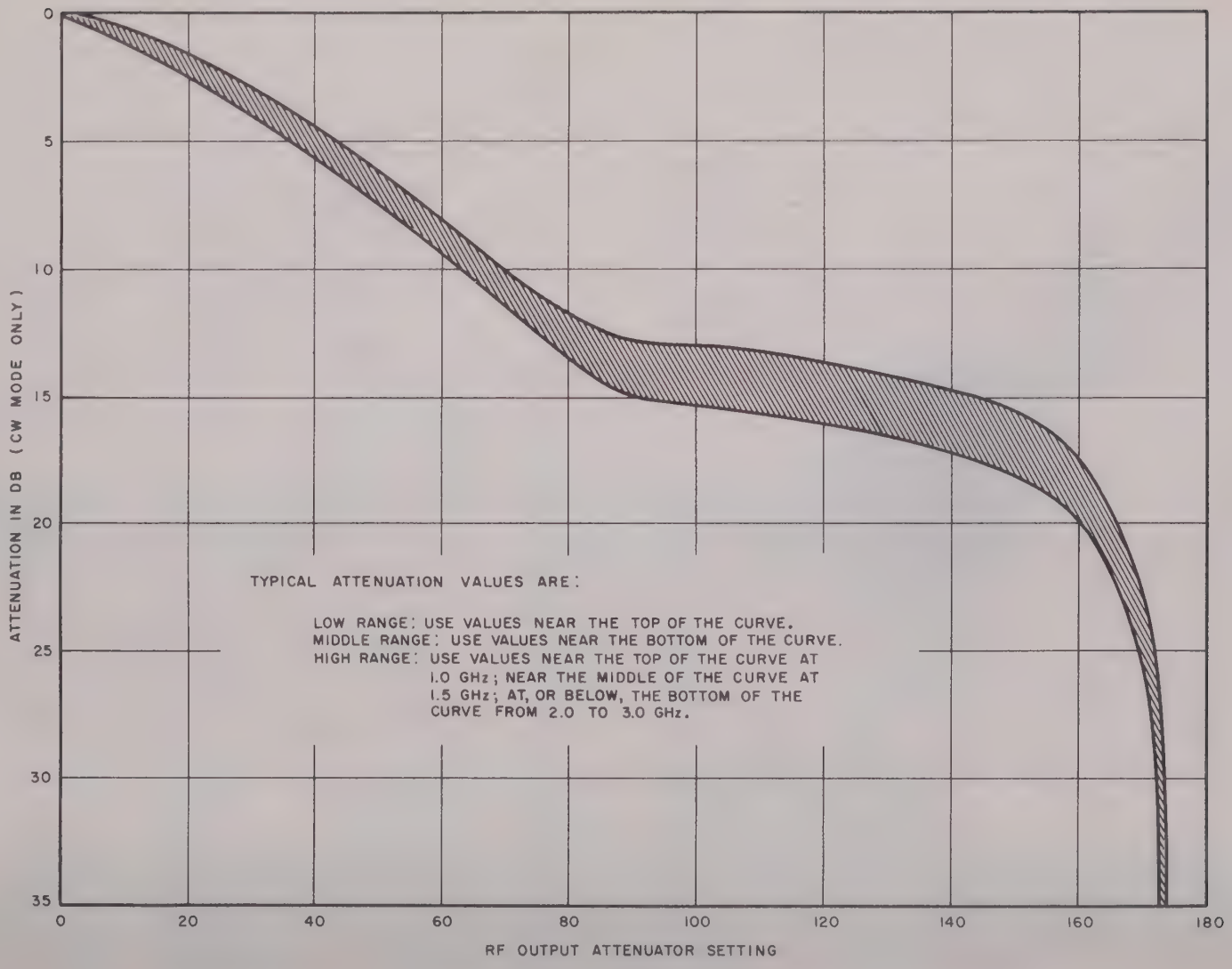


FIGURE 2-2. RF OUTPUT ATTENUATOR PERFORMANCE

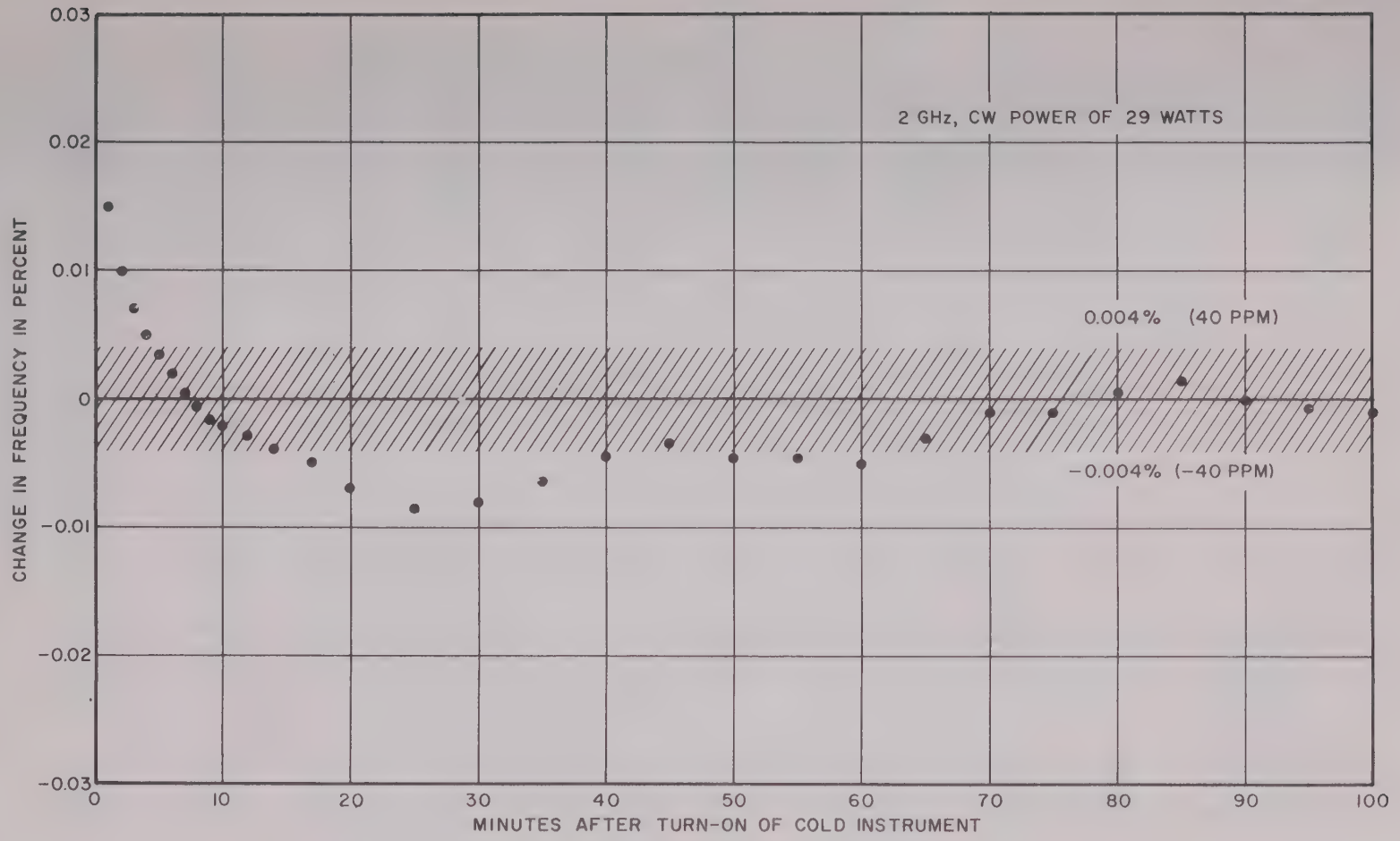


FIGURE 2-3. TYPICAL FREQUENCY STABILITY DURING WARMUP

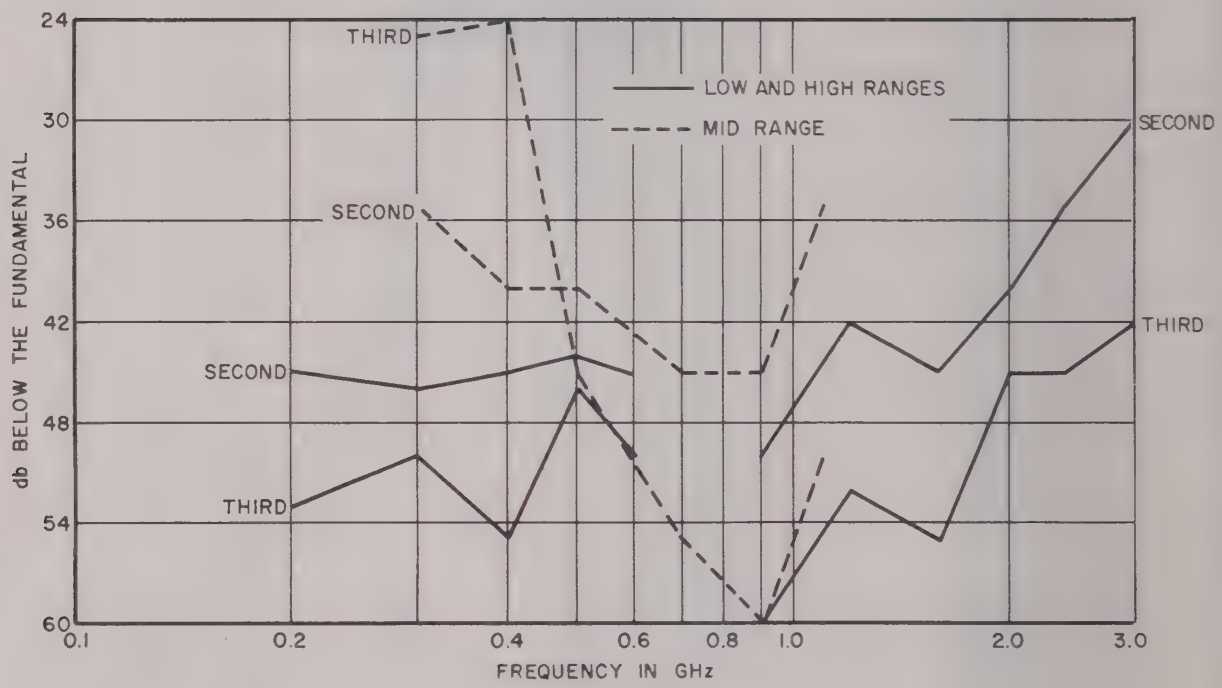


FIGURE 2-4. TYPICAL HARMONIC OUTPUTS IN CW OPERATION

MODULATION CAPABILITY

Internal Modulation	
Square Wave (100 percent)	400 Hz ±10 percent adjustable 1000 Hz ±10 percent adjustable
External Modulation	
AM	
Sine Wave (10 percent)	300 Hz to 10 kHz
Square Wave (100 percent)	300 Hz to 10 kHz
Input Requirement	At least 3 volts rms across 10 kilohms
Pulse (~100 percent) (Figures 2-5, 2-6, and 2-7)	
Width	0.5 to 25 μsec
Rise Time (Figure 2-6)	As low as 0.1 μsec
Fall Time (Figure 2-6)	As low as 0.3 μsec
Droop (Figure 2-7)	≤2 percent
Allowable Duty Cycle	≤5 percent
Residual CW Relative to Pulse Output (typical)	
LOW Range	>40 db down
MID Range	>50 db down
HIGH Range	>60 db down
Input Requirement (positive or negative)	At least 25 volts peak across 100 ohms

OUTPUT IMPEDANCE

50 ohms nominal. Maximum load SWR for previous specifications is 1.5 to 1; performance is not seriously degraded for load SWR's as great as 3 to 1. Load SWR's greater than 3 to 1 may damage the instrument unless the R. F. OUTPUT ATTENUATOR is set to at least 100.

INPUT POWER

115 volts ±10 percent, 4 amperes, 60 Hz ±2 Hz.

Notes: 230 volts ±10 percent, 2 amperes (Section 4-F for conversion procedure).

50-Hz line frequency cannot be used unless a special transformer is added.

DIMENSIONS

Figure 2-8 shows the outline and dimensions of the Power Signal Source.

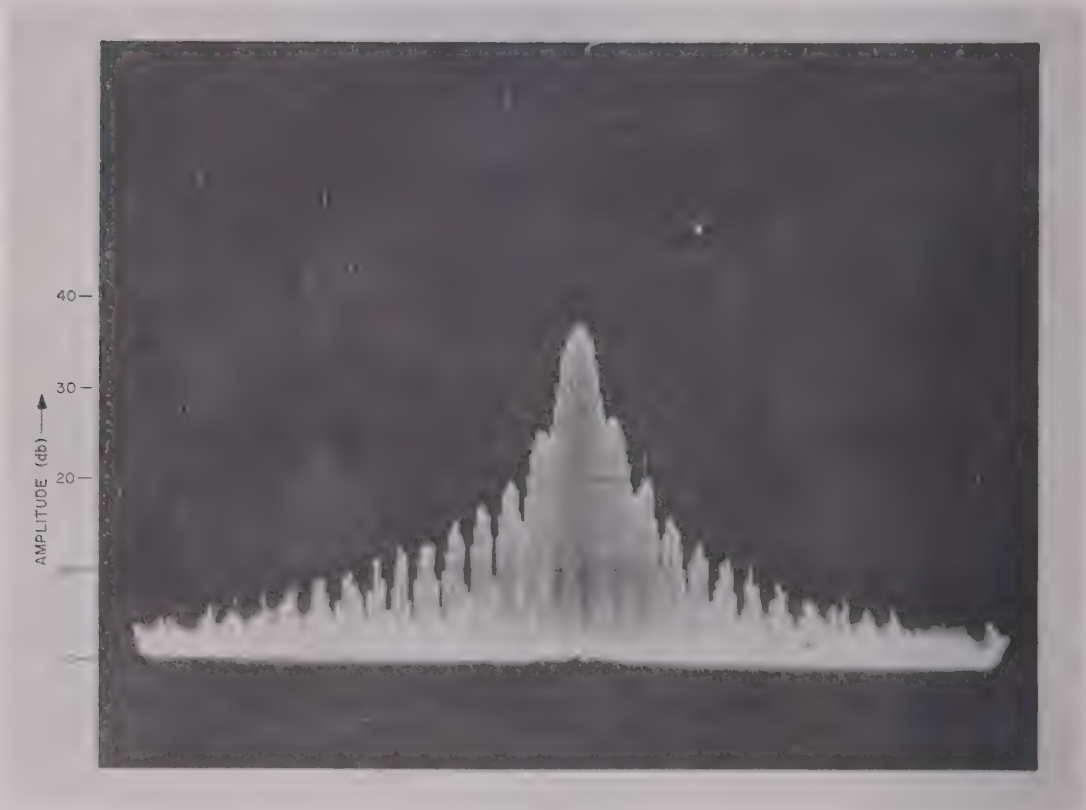


FIGURE 2-5. TYPICAL SPECTRUM OF 10-μSEC-WIDE, 1.2 GHz PULSE, PRF 5 kHz

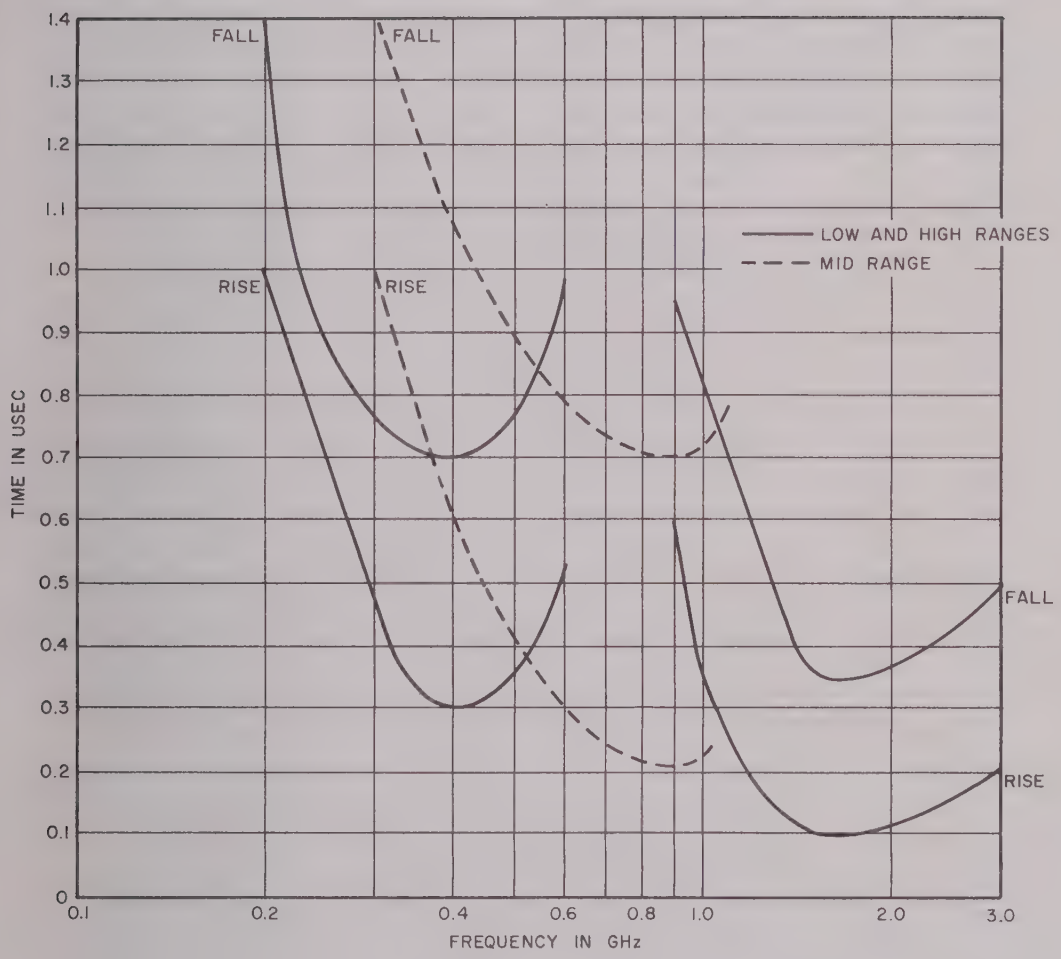


FIGURE 2-6. TYPICAL PULSE RISE AND FALL TIME RESPONSE

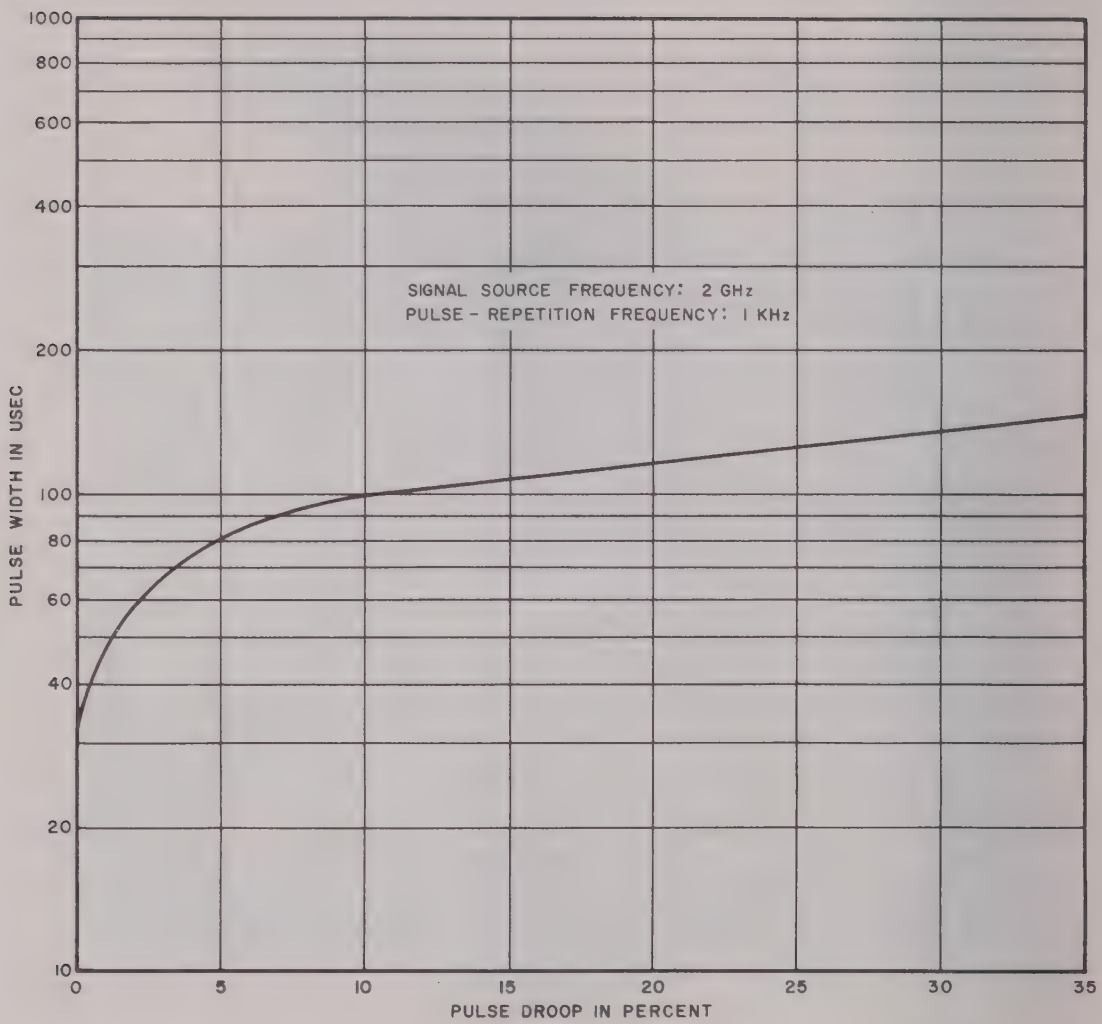


FIGURE 2-7. TYPICAL PULSE DROOP RESPONSE

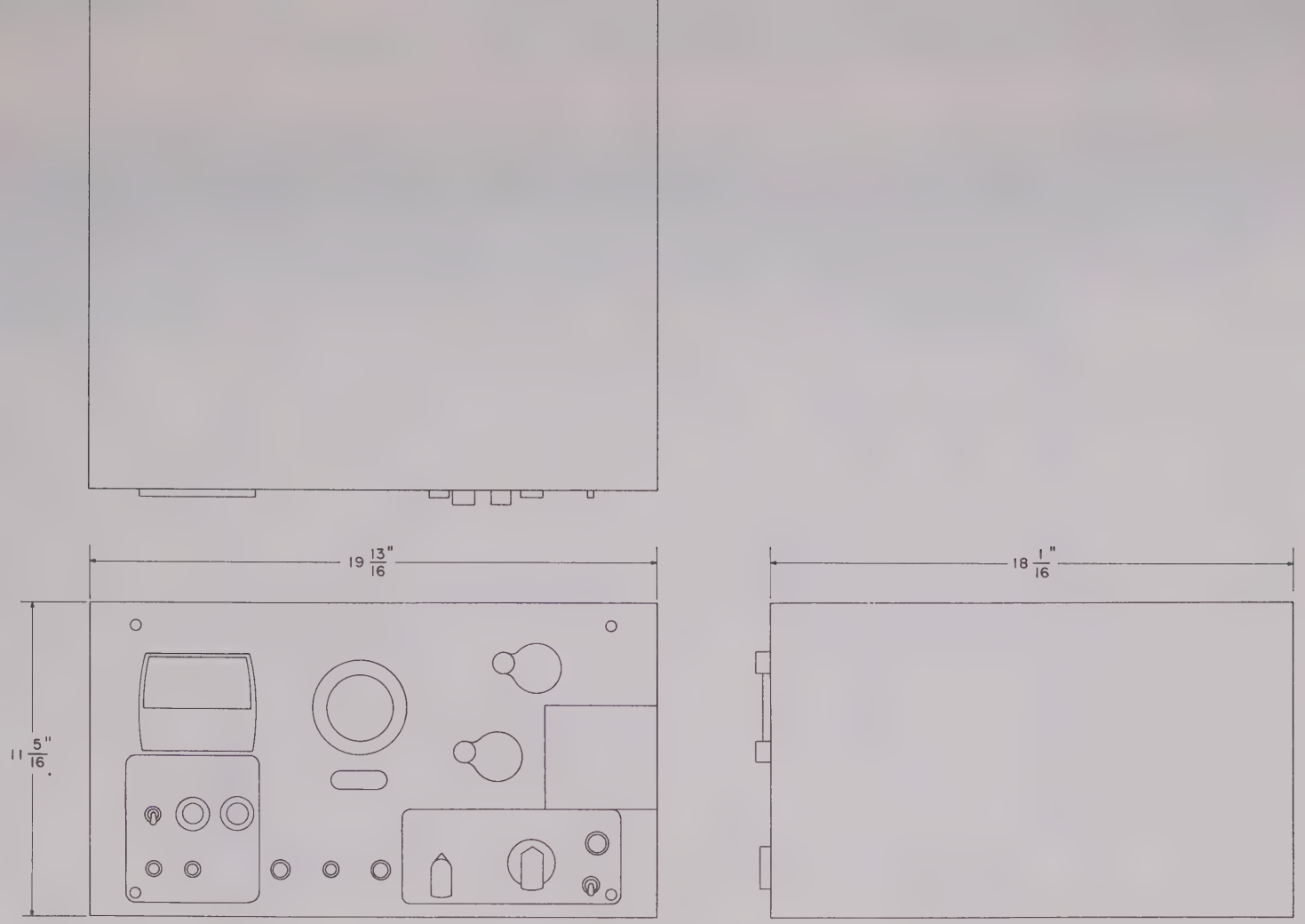


FIGURE 2-8. OUTLINE AND DIMENSION DRAWING

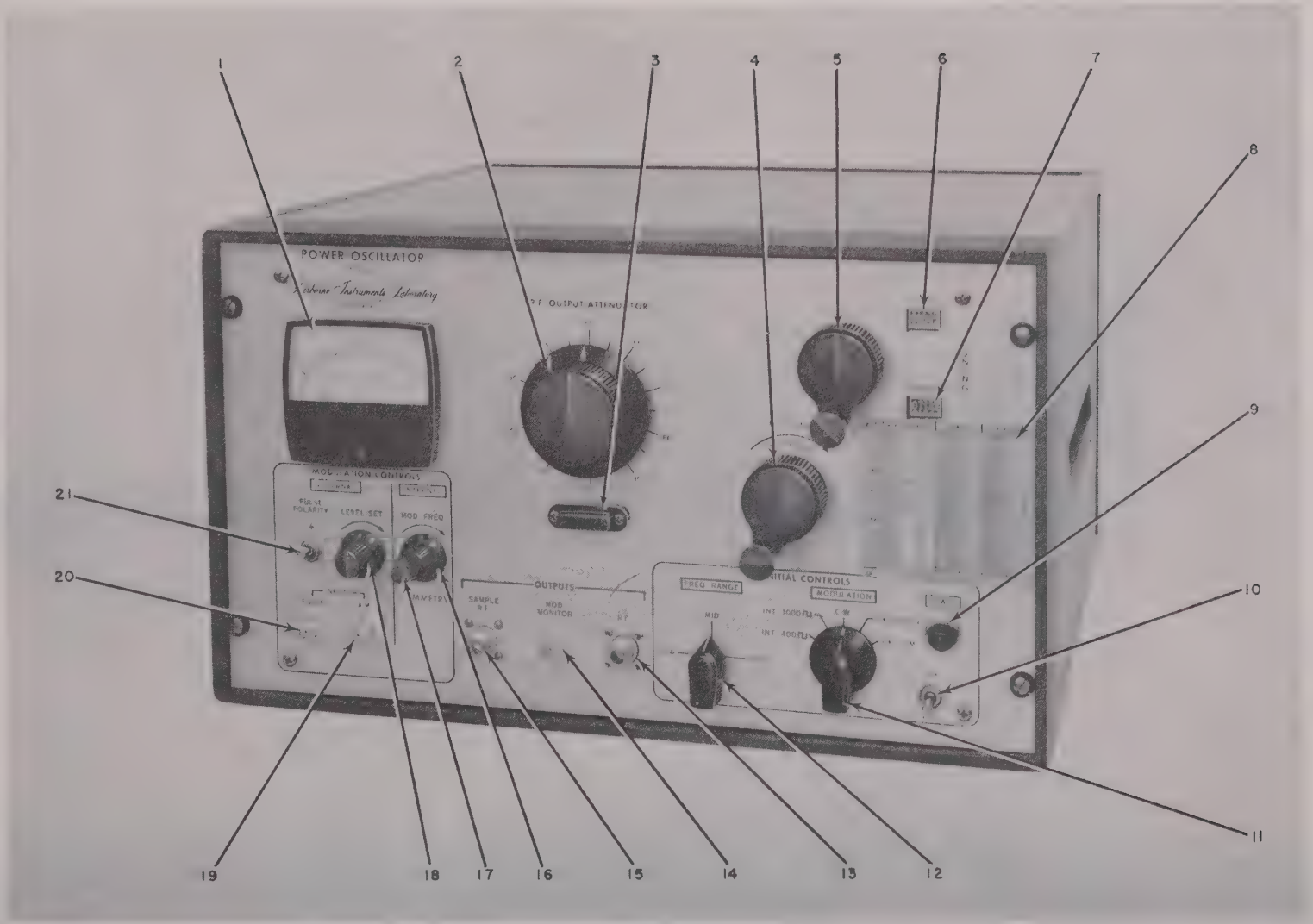


FIGURE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

SECTION 3

OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Front Panel Index No. (Figure 3-1)	Unit	Function
1	RELATIVE POWER Meter	Indicates relative power when operating in CW mode
2	R. F. OUTPUT ATTENUATOR	Adjusts R. F. OUTPUT and SAMPLE R. F. OUTPUT in all modulation modes (including CW) at least 30 db over most of the frequency range
3	+100 Lamp	Indicates change in R. F. OUTPUT ATTENUATOR range from 0-100 to 100-190
4	COUPLING Control	Provides for optimizing Signal Source performance for different modulation modes, power outputs, and RF load conditions. Also, can be used for very small attenuation steps (0. 05 db or less)
5	PLATE-CATHODE TUNING Control	Adjusts Signal Source frequency and provides for optimizing performance for different modulation modes, power outputs, and RF load conditions
6	PLATE Counter	Indicates position of plate-grid plunger
7	CATHODE Counter	Indicates position of cathode-grid plunger
8	Frequency Card	Provides PLATE and CATHODE counter settings for frequencies on the LOW and MID ranges (gray columns) and on the HIGH range (white columns)

Front Panel Index No. (Figure 3-1)	Unit	Function
INITIAL CONTROLS		
9	POWER Lamp	Indicates presence of plate voltage to tubes
10	POWER ON-OFF Switch	Controls input AC power
11	MODULATION Selector Switch	Selects one of five modes of modulation available
12	FREQ. RANGE Selector Switch	Selects one of three bias circuits for each of the three frequency ranges available
OUTPUTS		
13	R. F. OUTPUT Jack	High-power RF output from Signal Source (must always be connected to a load while the Signal Source is on unless the R. F. OUTPUT ATTENUATOR is set to at least 180)
14	MOD. MONITOR OUTPUT Jack	Detects output of modulation on the Signal Source RF output
15	SAMPLE R. F. OUTPUT Jack	Low-power RF output decoupled by 30 db from the high-power RF output; available for frequency or power monitoring and extremely low power (in microwatts and milliwatts) requirements
MODULATION CONTROLS		
16	INTERNAL MOD FREQ	Adjusts internal modulation frequencies of 400 and 1000 Hz by at least $\pm$10 percent
17	INTERNAL MOD SYMMETRY	Permits on and off periods of internal, square-wave modulation to be equalized
18	LEVEL SET	Adjusts external modulation input to external AM and pulse amplifier stages in the Signal Source

Front Panel Index No. (Figure 3-1)	Unit	Function
INPUTS		
19	A.M. Jack	Input jack of the Signal Source for an external, amplitude-modulation source
20	PULSE Jack	Input jack of the Signal Source for an external, pulse-modulation source
21	PULSE POLARITY Switch	Controls polarity of pulse signal presented to the pulse amplifier stages in the Signal Source

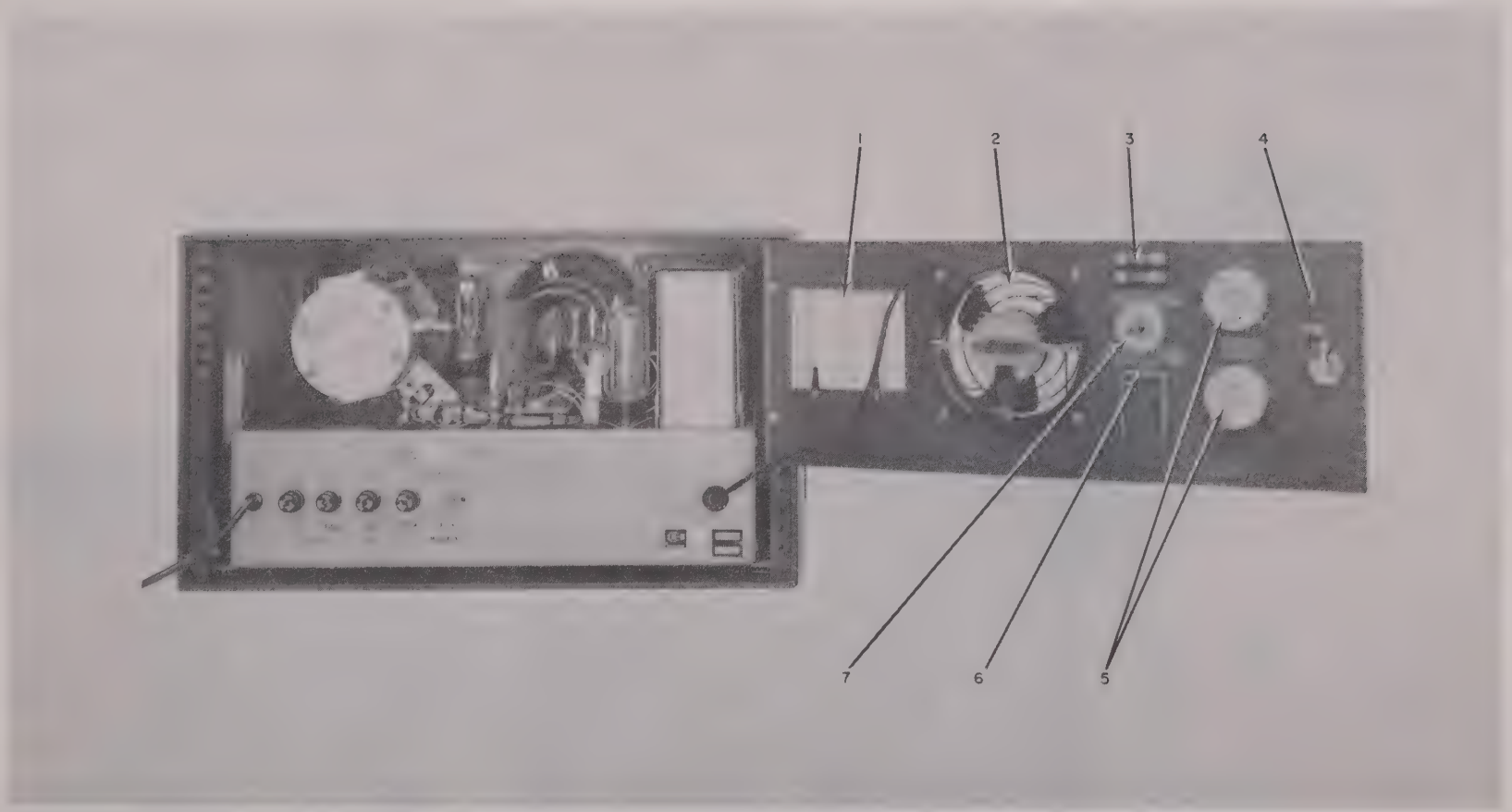


FIGURE 3-2. REAR PANEL ASSEMBLIES

Rear Panel Index No. (Figure 3-2)	Unit	Function
1	Frequency Card Holder	Stores spare frequency cards. Range-changing instructions appear on the back of the frequency cards
2	Chassis Blower	Cools all components on the top of the chassis
3	Fuse Holders	Store two 1-ampere 3AG fuses (replacements for F104)
4	Wrench Holder	Holds Allen wrench used in range-changing operation
5	Feedback Assembly Holders	Act as storage hubs for the two feedback assemblies not being used
6	Feedback Assembly and Cathode-Loading Element Extractor	Facilitates insertion, removal, screwing, unscrewing, and holding of feedback assembly and cathode-loading element during range-changing operations
7	LOW-Frequency Cathode-Loading Element	Adds to the grid-cathode tube capacitance when set onto the inner cylinder of the cavity on the LOW-frequency range only

SECTION 4
OPERATING INSTRUCTIONS

A. CHANGING FREQUENCY RANGES

The equipment is shipped with the HIGH-frequency feedback assembly in place, the coupling loop in, and the PLATE and CATHODE counters and COUPLING control set for operation at 1 GHz. To operate the equipment from 0.2 to 0.6 GHz (LOW-frequency range), or from 0.3 to 1.0 GHz (MID-frequency range), it is necessary to change the feedback assembly. Two feedback assemblies are always stored on hubs located on the inside face of the back panel (Figure 4-1). The assemblies may be removed (or installed) by loosening these hubs (or tightening) the three, red-dotted setscrews, and unscrewing (or screwing) each assembly with the special U-shaped extractor provided. DO NOT TOUCH THE GLYPTALED SETSCREW IN EACH FEEDBACK ASSEMBLY.

The cathode-loading element, the special U-shaped feedback assembly and cathode-loading element extractor, and the Allen wrench for the setscrews, are all stored on the inside of the back panel in special holders (Figure 3-2).

Before changing ranges, the COUPLING control should be set to minimum (fully counterclockwise) and the coupling loop should be withdrawn out of the cavity.

To change ranges, proceed according to the following instructions. All thumbscrews, stud bolts, and setscrews used in assembly and disassembly have been coded with red paint.

NOTE

These instructions are repeated on the back of the frequency cards stored on the back panel.

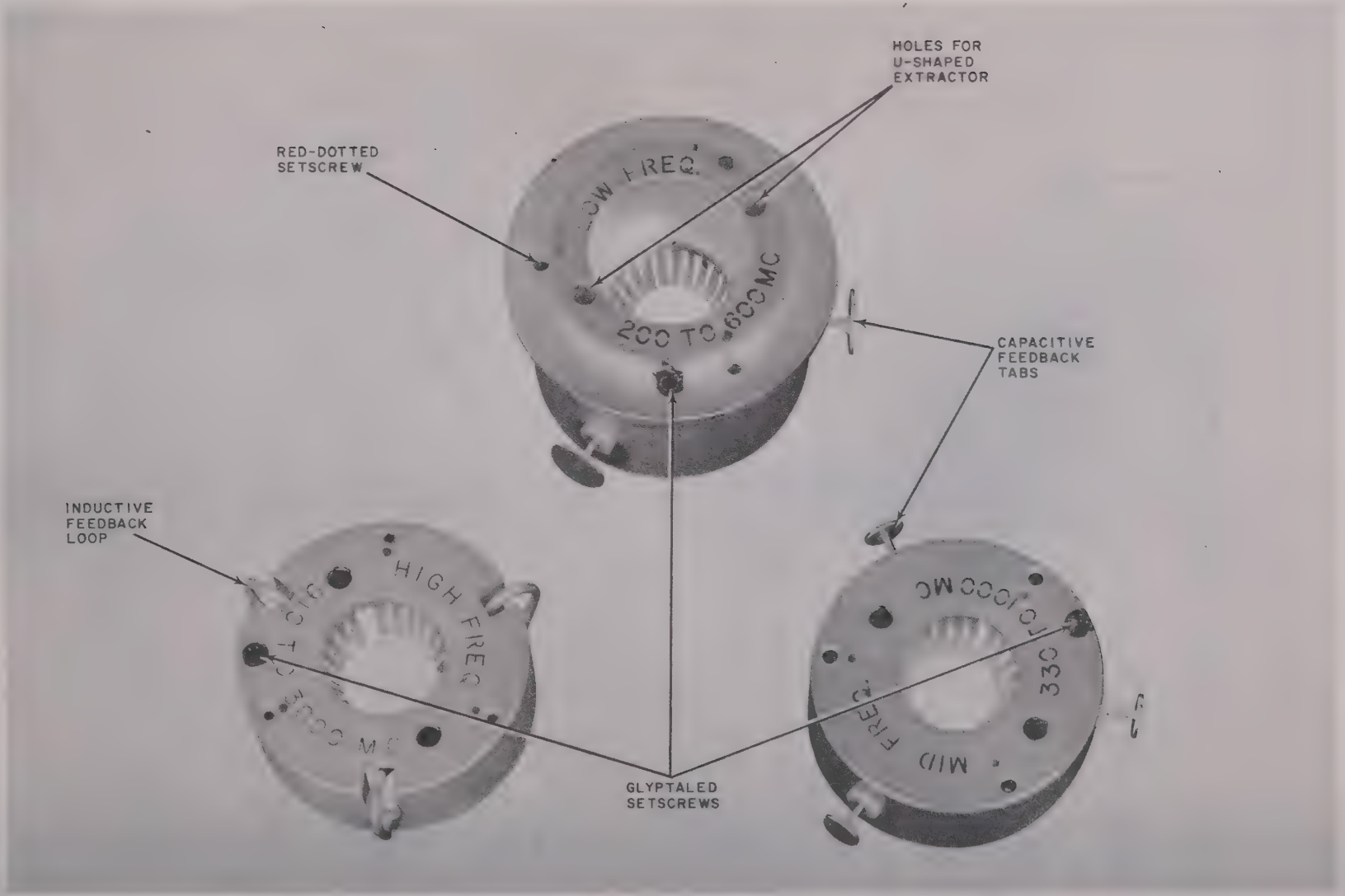


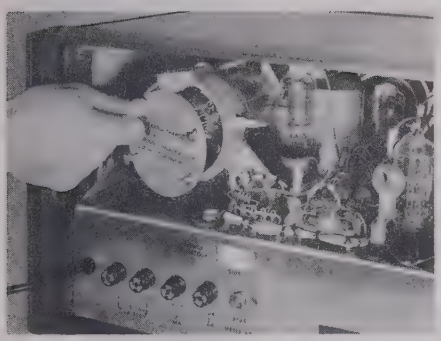
FIGURE 4-1. FEEDBACK ASSEMBLIES

1. MID- AND HIGH-FREQUENCY FEEDBACK ASSEMBLIES

REMOVAL PROCEDURE

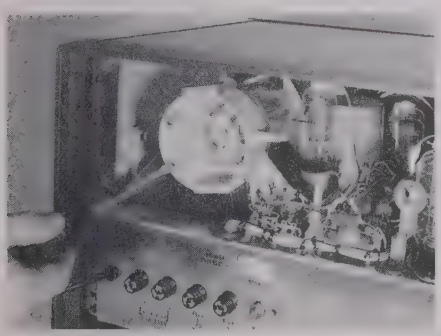
CAUTION

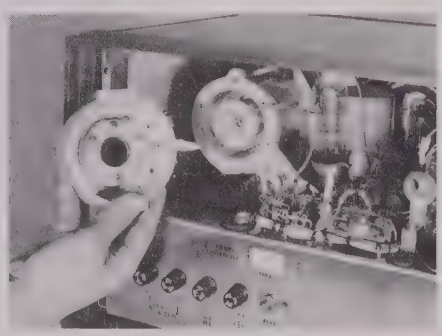
The RF tube gets extremely hot when operating for long periods at the maximum power output condition. To cool the tube before changing ranges, leave the POWER switch at ON and set the RF OUTPUT ATTENUATOR to its fully clockwise position (maximum attenuation) for 2 minutes. Turn the POWER switch to OFF and follow the instructions listed below.



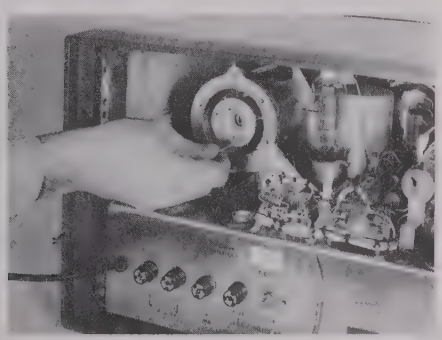
a. Remove the metal end plate from the rear of the unit by unscrewing the four, red thumbscrews.

b. Grasp RF tube V104 by the cooling fins and pull it out, using a clockwise twist to loosen the tube from the contact springs.



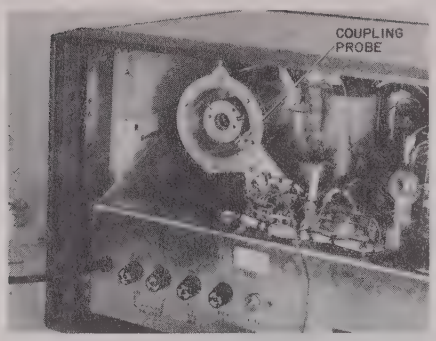


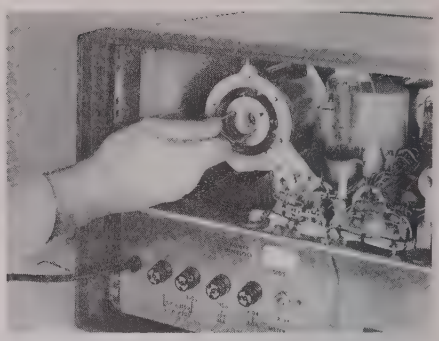
c. Remove the hat assembly of the cavity by unscrewing the four, red-tipped, stud bolts that hold the hat assembly to the outer cylinder. DO NOT LOOSEN THE SCREWS IN THE THREE, WHITE DELRIN BLOCKS; IF YOU DO, YOU MAY DAMAGE THE MICA CAPACITOR ASSEMBLY.



d. Loosen the three, red-dotted, Allen-head setscrews that lock the feedback assembly in place. DO NOT TOUCH THE GLYPTALED SETSCREW.

FIGURE 4-2. STEPS IN RANGE-CHANGING OPERATION (SHEET 1 OF 4)





e. Make sure that the coupling probe and loop are out of the way; then remove the feedback assembly by unscrewing it with the special U-shaped extractor provided.

f. Remove the desired feedback assembly from the back-panel hub by loosening the three, red-dotted, Allen-head setscrews and unscrewing it with the U-shaped extractor.

g. Mount the feedback assembly removed in step e onto the back-panel hub from which the desired feedback assembly has just been removed in step f. Screw it on the hub using the U-shaped extractor and tighten the three, red-dotted, Allen-head setscrews.

INSTALLATION PROCEDURE

h. Screw the desired feedback assembly into place on the cavity cylinder using the U-shaped extractor. The fourth glyptaled setscrew in each feedback assembly acts as a stop to limit the distance that the feedback assembly can be screwed in. THE TABS OR LOOPS ON THE FEEDBACK ASSEMBLY MUST BE CENTERED ABOUT THE COUPLING PROBE IF THE ASSEMBLY IS MOUNTED CORRECTLY. IF THIS LAST CONDITION IS NOT MET, THE COUPLING PROBE AND LOOP MAY STRIKE AND DAMAGE THE FEEDBACK ASSEMBLY WHEN COUPLING IS INCREASED.

i. Tighten the three, red-dotted, Allen-head setscrews that lock the feedback assembly in place.

j. Replace the hat assembly by tightening the four, red-tipped, stud bolts.

k. Replace the RF tube by gently inserting and twisting it at least one-quarter turn in a clockwise direction. Optimum tube cooling results when the slots in the tube radiator are aligned parallel to the air flow. Make sure the RF tube is pushed into the cavity as far as it can go.

l. Replace the metal end plate by tightening the four, red thumbscrews.

FIGURE 4-2. STEPS IN RANGE-CHANGING OPERATION (SHEET 2 OF 4)

2. LOW-FREQUENCY FEEDBACK ASSEMBLY

REMOVAL PROCEDURE

CAUTION

The RF tube gets extremely hot when operating for long periods at the maximum power output condition. To cool the tube before changing ranges, leave the POWER switch at ON and set the RF OUTPUT ATTENUATOR to its fully clockwise position (maximum attenuation) for 2 minutes. Turn the POWER switch to OFF and follow the instructions listed on the following pages.

a. Remove the metal end plate from the rear of the unit by unscrewing the four, red thumbscrews. See Figure 4-2, step a.

b. Grasp RF tube V104 by the cooling fins and pull it out, using a clockwise twist to loosen the tube from the contact springs. See Figure 4-2, step b.

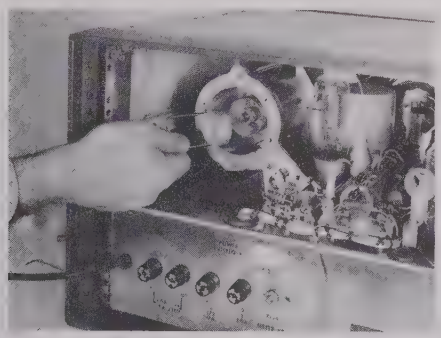
c. Remove the hat assembly of the cavity by unscrewing the four red-tipped stud bolts that hold the hat assembly to the outer cylinder. DO NOT LOOSEN THE SCREWS IN THE THREE, WHITE DELRIN BLOCKS; IF YOU DO, YOU MAY DAMAGE THE MICA CAPACITOR ASSEMBLY. See Figure 4-2, step c.

d. Loosen the three, red-dotted, Allen-head setscrews that lock the feedback assembly in place. DO NOT TOUCH THE GLYPTALED SETSCREW. See Figure 4-2, step d.

e. Make sure that the coupling probe and loop are out of the way; then remove the feedback assembly by unscrewing it with the special U-shaped extractor provided. See Figure 4-2, step e.

f. Remove the desired feedback assembly from the back-panel hub by loosening the three, red-dotted, Allen-head setscrews and unscrewing it with the U-shaped extractor.

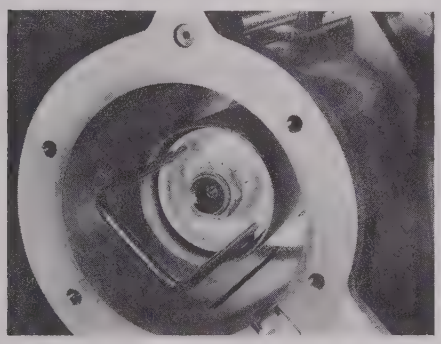
g. Mount the feedback assembly removed in step e onto the back-panel hub from which the desired feedback assembly has just been removed in step f. Screw it on the hub using the U-shaped extractor and tighten the three, red-dotted, Allen-head setscrews.



h. Grasp the inner groove in the cathode loading element with the special U-shaped extractor provided, and pull the element out.

i. Mount the cathode loading element on the back-panel hub provided for it.

INSTALLATION PROCEDURE



j. Before screwing the feedback assembly into place, push the cathode-loading element onto the cathode cylinder (inner cylinder), closed-end first, until the inner hub face of the cathode-loading element is aligned with the shoulder under the hexagonal nut at the end of the cathode cylinder.

FIGURE 4-2. STEPS IN RANGE-CHANGING OPERATION (SHEET 3 OF 4)

k. Screw the desired feedback assembly into place on the cavity cylinder using the U-shaped extractor. The fourth glyptaled setscrew in each feedback assembly acts as a stop to limit the distance that the feedback assembly can be screwed in. THE TABS OR LOOPS ON THE FEEDBACK ASSEMBLY MUST BE CENTERED ABOUT THE COUPLING PROBE IF THE ASSEMBLY IS MOUNTED CORRECTLY. IF THIS LAST CONDITION IS NOT MET, THE COUPLING PROBE AND LOOP MAY STRIKE AND DAMAGE THE FEEDBACK ASSEMBLY WHEN COUPLING IS INCREASED.

l. Tighten the three, red-dotted, Allen-head setscrews that lock the assembly in place.

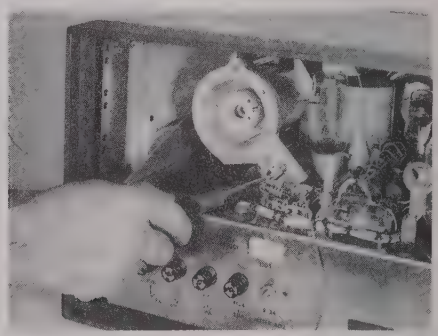
m. Replace the hat assembly by tightening the four, red-tipped, stud bolts.

n. Replace the RF tube by gently inserting and twisting it at least one-quarter turn in a clockwise direction. Optimum tube cooling results when the slots in the tube radiator are aligned parallel to the air flow. Make sure the RF tube is pushed into the cavity as far as it can go.

o. Replace the metal end plate by tightening the four, red thumbscrews.

3. COUPLING LOOP

a. To insert the coupling loop, loosen the red-tipped screw that holds it, and push the loop up into the cavity as far as it can go. Tighten the screw.



b. To remove the coupling loop, loosen the red-tipped screw, and pull the loop down as far as it will go. Tighten the screw.

NOTE

The coupling loop adjustment can be made while the Signal Source is on, since the loop is DC grounded.

FIGURE 4-2. STEPS IN RANGE-CHANGING OPERATION (SHEET 4 OF 4)

4. FEEDBACK ASSEMBLY AND COUPLING-LOOP SETTINGS

The following table shows the feedback assembly and coupling-loop settings required for operation at various frequencies:

Frequency Range (GHz)	Feedback Assembly Required	Setting of Coupling Loop
0.2 to 0.6	LOW-frequency	Out of cavity
0.3 to 1.0	MID-frequency	Out of cavity
0.9 to 3.0	HIGH-frequency	In cavity from 0.9 to 1.7 GHz Out of cavity from 1.8 to 3.0 GHz

B. INITIAL OPERATING PROCEDURES

The front panel layout (Figure 4-3) is designed to simplify use of the Signal Source. Operational procedures begin at the lower, middle area designated as OUTPUTS (SAMPLE R. F., MOD. MONITOR, and R. F.); then proceed counterclockwise to the INITIAL CONTROLS (FREQ. RANGE, MODULATION, and POWER switches); to the frequency card for the PLATE and CATHODE counter settings; then to the TUNING controls; to the R. F. OUTPUT ATTENUATOR; and finally to the MODULATION CONTROLS (INT. MOD. FREQ. and SYMMETRY adjustments, EXT. A.M. and PULSE INPUTS, the PULSE POLARITY switch, and the external-modulation LEVEL SET control). Initial operating procedures are as follows:

1. If frequency or power output monitoring, or a microwatt-output power is desired, connect a suitable meter or load to the SAMPLE R. F. OUTPUT jack.
2. If internal or external modulation is to be used, connect a suitable oscilloscope to the MOD. MONITOR OUTPUT jack.

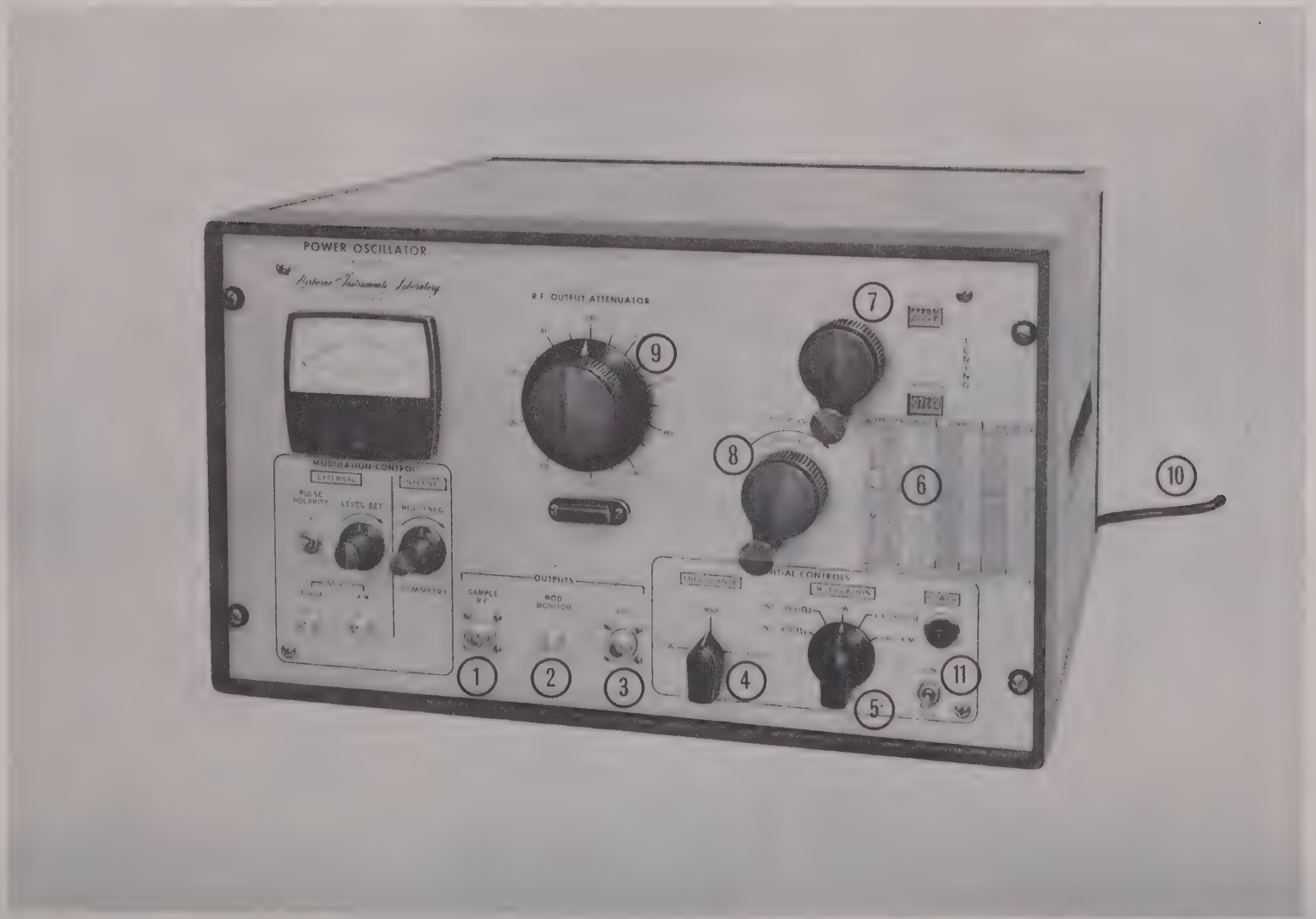


FIGURE 4-3. FRONT PANEL, TYPE 125, POWER SIGNAL SOURCE

3. Connect a load which is rated for the expected power output to the R. F. OUTPUT jack, whether or not this output will be utilized. To calculate the expected power output, obtain the typical power output from Figure 2-1 and reduce it by the attenuation read from Figure 2-2. DO NOT ATTEMPT TO OPERATE THE SIGNAL SOURCE WITHOUT SOME RF LOAD CONNECTED TO THE R. F. OUTPUT JACK UNLESS THE R. F. OUTPUT ATTENUATOR IS SET TO AT LEAST 180.

4. Set the FREQ. RANGE switch to the desired range (LOW, MID, or HIGH).

5. Set the MODULATION switch to CW. (Note: Regardless of the type of modulation desired, it is best to initially tune-up the Signal Source in the CW mode.)

6. Refer to the frequency card on the front panel (or the average tuning curves of Figures 7-1, 7-2, and 7-3) and select a PLATE counter reading and a CATHODE counter reading in the frequency range being used. Note that the gray columns on the card are for the PLATE and CATHODE counter settings of the LOW and MID ranges, while the white columns are for the HIGH range counter settings.

7. Turn the TUNING control until the PLATE counter reading is correct. Then disengage the PLATE control by pressing in on the knob, and turn the knob to set the CATHODE counter reading.

8. Reduce the coupling to minimum by turning the COUPLING knob fully counterclockwise.

9. Set the R. F. OUTPUT ATTENUATOR to at least 50 in order to reduce high-current transients during tuning.

10. Connect the AC line plug to a 115-volt $\pm$10 percent, 60-Hz source.

11. Set the POWER switch to ON. All vacuum tube filaments should light and the blowers should start. DO NOT ATTEMPT TO OPERATE THE SIGNAL SOURCE IF THE BLOWERS DO NOT START. (Note: If the rear panel door is opened, a power interlock will automatically interrupt the AC power to the instrument.)

12. To permit the cathode of RF tube V104 to reach operating temperature before plate voltage is applied, a time delay switch is installed (the delay is about 90 seconds). The pilot lamp above the switch should light when the plate voltage is applied.

C. CW ADJUSTMENT

The R. F. OUTPUT ATTENUATOR should be set to at least 50 before tuning for optimum power and before changing frequencies. This precaution should be observed to limit any high-current transients due to wrong modes or incorrect operating procedures. Fuse F104 is set to blow, to protect the RF tube, if this precaution is not heeded.

Proper tuning will maximize the RELATIVE POWER meter indication. To begin tuning, increase the amount of coupling by turning the COUPLING control clockwise. Continue until the meter indication is peaked. To aid in obtaining the maximum indication, tune the CATHODE control (press in on the TUNING knob before turning). Several adjustments of both the COUPLING and the CATHODE TUNING controls may be necessary in order to obtain a stable, maximum indication, especially during warmup and in the frequency region above 2.0 GHz.

The reading of the CATHODE counter should agree closely with that obtained from the front-panel frequency card or the average tuning curves (Figures 7-1, 7-2, and 7-3). Points very far off may represent another mode of oscillation, resulting in a different Signal Source frequency. PLATE and CATHODE counter settings for frequencies other than those enumerated on the front-panel frequency card may be obtained either by interpolation or by consulting the average tuning curves.

TUNING NOTES

LOW RANGE

DO NOT increase the CATHODE counter setting above 06600. This would result in the dislodging of the cathode-loading element and possible damage to the feedback assembly. This precaution may be disregarded as long as the equipment is operated below 0.63 GHz.

MID RANGE

When tuning to 1.0 GHz, or above, check that the CATHODE counter setting does NOT exceed 07475. Otherwise, DAMAGE MAY RESULT TO THE FEEDBACK ASSEMBLY. Fuse F104 is set to blow, so as to protect the RF tube, if this precaution is not heeded.

HIGH RANGE

COUPLING CONTROL

At many frequencies, there will be two positions of the COUPLING control which peak the RELATIVE POWER meter. Choose the position which gives the maximum indication. In general, the extreme counterclockwise position will give best results except for the region from 0.9 to 1.2 GHz, where the extreme clockwise position is best. As 3.0 GHz is approached, the optimum COUPLING position is almost the extreme counterclockwise position obtainable (minimum coupling).

COUPLING LOOP

Best performance is usually obtained with the loop inserted all the way into the cavity from 0.9 to 1.7 GHz, and all the way out of the cavity from 1.8 to 3.0 GHz. However, in some cavities, the opposite loop position may give best performance at certain frequencies in the 1.6 to 1.9 GHz region and the 2.4 to 2.8 GHz region.

TUNE-UP TIME

Standard tune-up procedures usually produce a stable operating point in a matter of seconds. However, above 2.0 GHz, the stability of the Signal Source is much more dependent on thermal equilibrium in the cavity. Consequently, above 2.0 GHz, several minutes may be required for trimming of the COUPLING and CATHODE TUNING controls before stable operation is attained. In this frequency region, best results are usually obtained by initially tuning the Signal Source at an R. F. OUTPUT ATTENUATOR setting of 25, and allowing it to warm up for a few minutes at that setting.

D. ATTENUATOR ADJUSTMENT

1. VARIABLE ATTENUATION

After a maximum indication on the RELATIVE POWER meter has been obtained, the R. F. OUTPUT ATTENUATOR may be adjusted for the exact level of power output desired (see Figure 2-2 for typical attenuation values versus ATTENUATOR settings). Power output is decreased as the R. F. OUTPUT ATTENUATOR knob is turned clockwise (that is, higher numbers indicate greater attenuation). Each adjustment of the R. F. OUTPUT ATTENUATOR may require a slight trimming of the COUPLING and CATHODE TUNING controls in order to optimize the Signal Source stability (optimization would correspond to a maximum RELATIVE POWER meter indication on the CW mode and best wave shape on any other modulation mode). The attenuator-caused frequency shift should be less than ± 0.25 percent, except for frequencies above 2.0 GHz where the shift may be as great as 1 percent.

Variation of the R. F. OUTPUT ATTENUATOR setting from 0 to 100 will produce more than a 10-db reduction in power output for the CW, INT. 400⊓⊔, INT. 1000⊓⊔, and EXT. A.M. modes of operation. In the EXT.PULSE mode, attenuation values of the order of 140 will be required in order to achieve more than a 10-db reduction in power output. In general, the higher the Signal Source frequency, the lower will be the numbered setting of the R. F. OUTPUT ATTENUATOR for a given db amount of attenuation.

The CW mode power output may be adjusted by the R. F. OUTPUT ATTENUATOR and by the COUPLING control. Since the R. F. OUTPUT ATTENUATOR is simple to adjust and reset, it is recommended that the COUPLING control be used only where extremely fine changes of power output are desired (less than 0.0500 db), and for extremely low power outputs where the R. F. OUTPUT ATTENUATOR becomes too coarse an adjustment.

The EXT. PULSE mode power output may be adjusted by the R. F. OUTPUT ATTENUATOR and by the LEVEL SET control. However, it is recommended that the LEVEL SET control be used only as a trimmer to obtain best wave shape, along with the COUPLING and CATHODE TUNING controls, and that the R. F. OUTPUT ATTENUATOR be used to adjust pulse-power output.

The EXT. A. M. mode power output may be adjusted by the R. F. OUTPUT ATTENUATOR and by the LEVEL SET control. A relatively constant percent modulation may be obtained when the R. F. OUTPUT ATTENUATOR is used if the RF power, as monitored at the SAMPLE R. F. OUTPUT, and the modulation power, as monitored at the MOD. MONITOR OUTPUT, are kept in a constant ratio by adjustment of the LEVEL SET control. Care should be taken to preserve best wave shape through periodic trimming of the COUPLING and CATHODE TUNING controls.

The "+100" lamp will light when the R. F. OUTPUT ATTENUATOR value exceeds 100. This indicates that all front panel attenuator values should be increased by 100 (for example, 20 is thus read as 120). The range of possible R. F. OUTPUT ATTENUATOR values is thus 0 to 190.

2. FIXED ATTENUATION

A fixed attenuation of 30 $\pm$3 db is available at the SAMPLE R. F. OUTPUT jack. Since the variable attenuator range is at least 33 db, the total attenuation range available is at least 60 db. A LOAD MUST STILL BE CONNECTED TO THE MAIN R. F. OUTPUT WHEN

THE SAMPLE R. F. OUTPUT IS USED, UNLESS THE R. F. OUTPUT ATTENUATOR IS SET TO AT LEAST 180.

E. MODULATION ADJUSTMENT

The FIRST step in ALL of the following subparagraphs is to turn the MODULATION switch to CW and tune the Signal Source to the desired frequency at approximately the desired power output level (refer to paragraph C of this section). In ALL of the following subparagraphs, adjustments in the COUPLING and/or the CATHODE TUNING controls may be needed to obtain the best waveform.

It is not uncommon to find that the CATHODE counter setting for optimum modulation wave shape is several hundred digits different than the optimum CW-mode setting. Such a difference will have a relatively minor effect on Signal Source frequency.

To observe the negative portion of the modulated RF waveform, connect an oscilloscope to the MOD. MONITOR OUTPUT terminal. The R. F. OUTPUT ATTENUATOR may be used in all modulation modes to vary the output level. The typical frequency shift, when going from CW to any modulation mode will be less than 0. 25 percent, and will be less than 0. 5 percent over most of the range of the R. F. OUTPUT ATTENUATOR.

1. INTERNAL SQUARE-WAVE MODULATION

Set the MODULATION switch to INT. 400⊓⊔ or INT. 1000 The CATHODE and the COUPLING TUNING controls may be varied to obtain the squarest wave shape. The 400- or 1000-Hz modulation frequency may be varied at least ±10 percent by turning the INTERNAL MOD. FREQ. knob. The modulation frequency is increased by turning the knob clockwise. Symmetrical on and off periods can be obtained by using the SYMMETRY control. Note that the typical peak square-wave power output on the HIGH range may be two to three times greater than the typical CW power output shown in Figure 2-1.

2. EXTERNAL AMPLITUDE MODULATION

Connect an oscillator to the front panel terminal marked A.M. INPUT and turn the LEVEL SET knob fully counterclockwise. The oscillator should be set to deliver at least 3 volts rms into a 10-kilohm load. Turn the MODULATION switch to EXT. A.M. Turn the LEVEL SET knob clockwise until the best possible wave shape is obtained. The COUPLING and CATHODE TUNING controls may be varied to obtain a better wave shape. To maintain a relatively constant percent modulation as the RF output power is varied, refer to the discussion in paragraph D of this section.

3. EXTERNAL PULSE MODULATION

Connect a pulse generator to the front panel terminal marked PULSE INPUT and turn the LEVEL SET knob fully counterclockwise. The pulse generator should be set to deliver at least 25 volts peak into 100 ohms. Turn the MODULATION switch to EXT. PULSE. Set the PULSE POLARITY switch to POSITIVE or NEGATIVE, depending upon the polarity of the input pulses being used.

Turn the LEVEL SET knob clockwise until the best possible wave shape is obtained. Thereafter, the LEVEL SET, COUPLING, and CATHODE TUNING controls (in that order) should be varied to obtain the sharpest rise and fall times and flattest top (see Figures 2-6 and 2-7 for typical performance).

The RF output level may be varied by either the R. F. OUTPUT ATTENUATOR or the LEVEL SET control. The R. F. OUTPUT ATTENUATOR control is recommended for best performance. Due to the low average tube current, attenuation values exceeding 100 will be required to significantly reduce the pulsed RF output level. Note that typical peak pulse power output on the HIGH range may be two to three times greater than the typical CW power output shown in Figure 2-1.

The LEVEL SET control may be used to reduce incidental AM and FM caused by overdriving the grid of the RF tube. The almost-perfect pulse spectrum, shown in Figure 2-5, was obtained by lowering the pulse level by 1 db from maximum output using the LEVEL SET control.

Pulse rise and fall times measured at the MOD. MONITOR OUTPUT are affected by the bandwidth of the internal detector circuit. To maximize this bandwidth and optimize the fidelity of detection, the MOD. MONITOR OUTPUT should be terminated by the lowest impedance load possible, commensurate with the sensitivity of the oscilloscope (50 ohms is recommended).

F. CONVERTING TO 230-VOLT OPERATION

When delivered, the Signal Source is wired for 115-volt input operation unless a sticker on the back panel states otherwise. To convert the Signal Source to 230-volt operation, the parallel-connected primary of transformer T101 must be series-connected, the 5-ampere fuses F101 and F102 must be replaced by 2.5-ampere fuses, and the loads across each of the series-connected primary windings must be equalized.

The servicing of transformer T101 and the equalization of the loads across its primary windings can be accomplished at the terminal strip shown in Figures 4-4 and 7-4. For 115-volt operation, jumpers connect terminals 1 to 3, 2 to 4, 1 and A, and 2 to B. To convert to 230-volt operation, remove two jumpers and connect the remaining two jumpers between terminals 2 to 3 and 1 to B. Also, replace the 5-ampere fuses with 2.5-ampere (S1o-B1o) fuses. Refer to Figure 4-4 for terminal board wiring.

G. EXTRA PERFORMANCE NOTES

As in all instruments, many final performance specifications are compromises. However, in the Type 125 Power Signal Source, the operator is given the option of making "design changes" to achieve

some superior performance characteristics other than those quoted. Examples are:

1. CW AND SQUARE-WAVE POWER

RF tube life and stability are the prime limitations on the power output capabilities of the instrument. If shorter tube life and poorer stability are no detractions, the operator may achieve from 10 to 100 percent more power output on the LOW and HIGH ranges by setting the FREQ. RANGE selector switch to MID and SLOWLY decreasing the R. F. OUTPUT ATTENUATOR setting from 50 to 0. This allows the RF tube plate voltage to increase typically from 1000 to 1150 volts on the LOW range, and 900 to 1150 volts on the HIGH range. If the RELATIVE POWER meter indication fails to increase smoothly

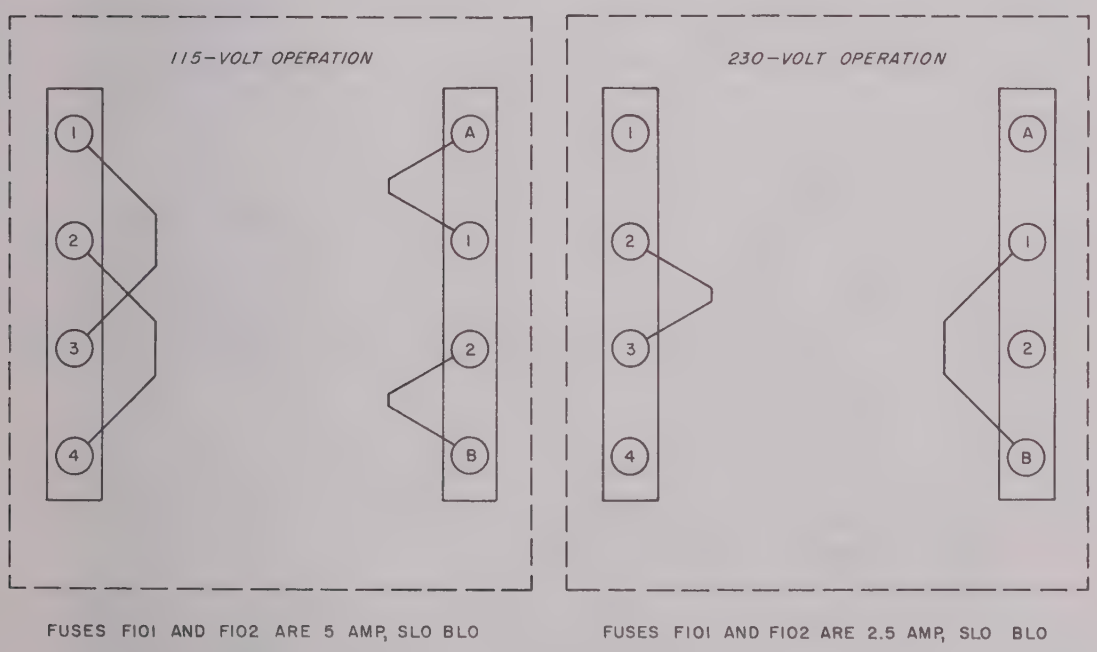


FIGURE 4-4. TERMINAL BOARD WIRING FOR 115-VOLT OR 230-VOLT OPERATION

as the R. F. OUTPUT ATTENUATOR setting is being decreased (power increased), the operator should stop and increase attenuation slightly since he is exceeding the RF tube capabilities at that point.

2. PULSE POWER

Since RF tube dissipation is greatly reduced under pulse operation, an external voltage supply may be used to increase the pulse power output of the Signal Source by a factor of two to ten times. Typical results are shown in Figure 4-5. Only two connection changes need be made--one is the high-voltage lead entering the anode hat assembly through the filter (Note: the filter is rated at 3 kVDC maximum); the other change is the B+ return lead which may be soldered onto F103. The instrument MUST be tuned up with the MODULATION selector switch set to EXT. PULSE to prevent damage to the RF tube. The PLATE and CATHODE counter settings will change very little from their standard settings. Initially, set the external voltage to 600 volts and tune for best wave shape following the instructions in paragraph E of this section. Then, slowly increase the voltage, each time increasing the LEVEL SET value (turn clockwise) to preserve best wave shape.

3. FREQUENCY COVERAGE

Each of the three ranges of the instrument can cover almost a double octave. Stability is somewhat poorer at the frequency extremes, and the precautions mentioned in paragraph C of this section must be strictly followed. The typical instrument will have the following frequency capabilities:

LOW range: 0.19 to 0.73 GHz
MID range: 0.29 to 1.2 GHz
HIGH range: 0.86 to 3.25 GHz

After some familiarty is gained with the instrument, the operator should find that infrequent range changes (because of the 3 to 1 frequency coverage of each range) is made even more infrequent by the almost 4 to 1 frequency capability of each range.

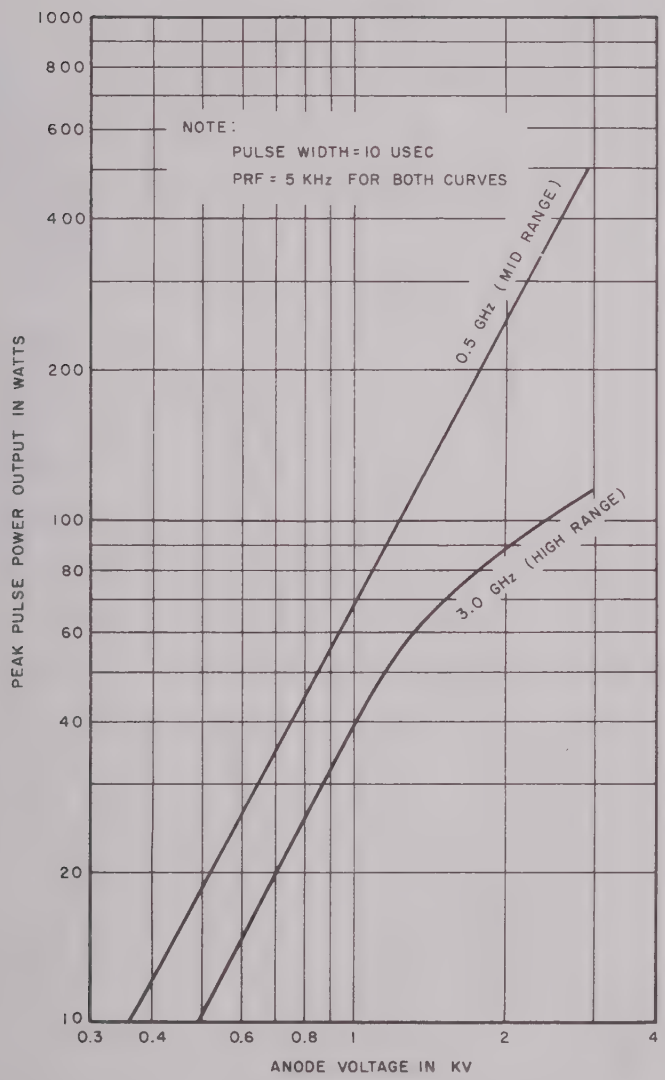


FIGURE 4-5. TYPICAL PEAK PULSE POWER OUTPUT VS ANODE VOLTAGE

4. DIRECT POWER READOUT

The RELATIVE POWER meter may be used as an absolute power meter for frequencies ranging from 0.2 to 1.5 GHz, and for power levels above 10 watts. Accuracies obtainable should be as good $\pm$1 db, or better, if the following two steps are taken: (1) measure the power output accurately at the midband frequency of interest, and (2) set the RELATIVE POWER meter (by means of the METER ADJ. potentiometer R134 on the back panel) to that power, presuming that the scale is 10 to 100 watts instead of 0.1 to 1.0.

SECTION 5
THEORY OF OPERATION

The Type 125 Power Signal Source consists essentially of an RF oscillator, a square-wave generator, a modulator, a power supply, and an attenuator.

A. RF OSCILLATOR

1. STRUCTURE

RF oscillator tube V104 is mounted coaxially within the cylindrical lines at the rear of the cavity structure, which is closed by a metal end plate. Contact to the grid, plate, and cathode of the tube is made all the way around by spring contacts. The grid of the tube is connected directly to the end of the middle cylinder; the plate and cathode are connected to the outer and inner cylinders, respectively, through capacitors C114 and C113.

Two shorting-plungers slide between the concentric lines to vary the lengths of the active portions of the lines that form resonant cavities. The plungers are driven by lead screws from the gear box and the main TUNING knob. Provision is made for adjusting the grid-cathode plunger (hereinafter referred to as the CATHODE control) independently of the grid-plate plunger (hereinafter referred to as the PLATE control) by pushing the TUNING knob in; this operation disengages the PLATE control drive. If the controls are properly adjusted, the oscillator will operate on odd quarter-wavelengths.

2. MODES OF OSCILLATION

For the LOW-frequency and MID-frequency ranges (0.2 to 0.6 GHz and 0.3 to 1.0 GHz), the coaxial oscillator is operated in the fundamental ($\lambda/4$) mode; for the HIGH-frequency range (0.9 to 3.0 GHz), the cavity is operated in the $3\lambda/4$ mode.

For any mode of modulation, the setting of the PLATE TUNING control is the primary frequency determinant. For a given PLATE setting, however, there are several settings of the CATHODE that will produce oscillations. These oscillations, which are quite distinct, correspond to $\lambda/4$, $3\lambda/4$, $5\lambda/4$, and $7\lambda/4$ modes. In the LOW- and MID-frequency ranges, only the $\lambda/4$ mode and a weak $3\lambda/4$ mode appear; on the HIGH-frequency range, all of the modes may appear. BECAUSE OF THIS, IT IS NECESSARY TO ADHERE RATHER CLOSELY TO THE COUNTER SETTINGS CALLED OUT ON THE FRONT PANEL FREQUENCY CARD, OR THE AVERAGE TUNING CURVES (Figures 7-1, 7-2, and 7-3), TO KEEP FROM WORKING ON AN UNDESIRED FREQUENCY.

The counter settings are most accurate for CW operation at maximum power output levels. Since optimum tuning is dependent on the RF tube impedances, there will be some deviation from these counter settings as the current in the tube is varied. Thus, when using the R. F. OUTPUT ATTENUATOR, or for modulation modes other than CW, the PLATE, CATHODE, and COUPLING TUNING controls will require adjustment for maintaining optimum performance.

3. FEEDBACK ASSEMBLIES

Capacitive feedback coupling is used to produce oscillation in the LOW- and MID-frequency ranges. The LOW- and MID-frequency assemblies provide three tabs in the plate cavity which are connected, via insulated probes, to a ring in the cathode cavity (Figure 4-1).

Inductive feedback coupling is used to produce oscillation in the HIGH-frequency range. The HIGH-frequency assembly provides three S-shaped loops; one loop of each "S" is in the plate cavity, and the other loop is in the cathode cavity (Figure 4-1).

4. TUNING RANGE

The lowest frequency to which the Power Signal Source can be tuned is determined by the mechanical limit of travel of the plate plunger away from the RF tube; this minimum frequency is about

0.19 GHz. The highest frequency at which the Signal Source can be used is determined primarily by the limitations of RF tube V104. Power output can be obtained at frequencies as high as 3.3 GHz, but the limit of useful output will vary considerably with different RF tubes.

5. TRACKING

The lead screws that drive the cathode and plate shorting-plungers are geared in such a manner that excellent tracking is accomplished over most of the LOW- and MID-frequency ranges. With a load having a low SWR over the frequency range, single-knob operation should be possible with periodic adjustments of the COUPLING control. Best results will be obtained if the CATHODE and PLATE TUNING controls are aligned for optimum output at a reading of 5000 on the PLATE counter.

Tracking on the HIGH-frequency range is not nearly as good, and it will usually be necessary to trim the CATHODE and COUPLING controls every 0.1 to 0.2 GHz.

6. OUTPUT IMPEDANCE, COUPLING CONTROL, AND COUPLING LOOP

The Power Signal Source is essentially a variable source-impedance generator. The COUPLING control acts as a single-stub tuner, helping to match the load to the RF tube, and vice versa. Although an exact conjugate match is rarely achieved, the COUPLING control permits optimum power transfer within $\pm$0.25 db to be achieved over the entire frequency range for load SWR's less than 1.5. Load SWR's as high as 3.0 cause slight degradation in performance.

The RF load is impedance-matched to the cavity by an adjustable, capacitive coupling probe. Maximum coupling (not necessarily the best power match) is obtained by tuning the COUPLING control fully clockwise to its stop. Because the RF field within the cavity changes with frequency, pure capacitive coupling does not permit optimum matching over the lower-half of the HIGH-frequency range.

When operating from 0.9 to 1.7 GHz, inductive coupling is best and is obtained by inserting the coupling loop. For satisfactory capacitive coupling on the LOW- and MID-frequency ranges, and upper-half of the HIGH-frequency range, it is best to remove the coupling loop.

7. BLOWERS

The RF tube plate dissipation is rated in excess of 175 watts when cooled by the 30-cfm forced air from blower B101. Typical plate dissipation is less than 100 watts at maximum power output, well-within allowable limits as long as blower B101 is on. Optimum RF tube cooling results when the slots in the tube radiator are aligned parallel to the airflow.

The chassis is cooled by 100-cfm forced air from blower B102. There is no danger to chassis components if blower B102 is off during maintenance checks; however, the cooling is required during normal usage of the instrument for obtaining best component reliability and life.

8. CATHODE-BIAS CIRCUIT

The RF tube cathode-bias circuit consists partially of an Amperite 2A20 ballast tube, which has the property of increasing its resistance with increasing current. This provides an automatic bias that improves the stability of the Signal Source. Different shunt resistors are switched in for different frequency ranges to optimize the stability and spectral purity of the output of the Signal Source.

9. GRID-BIAS CIRCUIT

A transistorized grid-current limiter automatically protects the RF tube from excessive grid currents in the CW mode. Diode CR103 essentially becomes a short at grid currents of the order of 45 ma, thus clamping the emitter-base voltage of Q101 and causing the collector-emitter voltage to increase sharply to oppose further current increase.

10. DIRECTIONAL COUPLER

The directional coupler consists of two, small, resistively terminated loops inserted into the electromagnetic field surrounding the center conductor of a coaxial line. The orientation of the loops with respect to this field determines the amount of coupling, which is about 30 db down for the SAMPLE R. F. OUTPUT arm and about 40 db down for the MOD. MONITOR OUTPUT arm. A filter element is used in the SAMPLE R. F. OUTPUT arm to compensate for the inherent coupling variation over the frequency range, thus achieving a 30 $\pm$3 db coupling ratio relative to the main R. F. OUTPUT arm over the entire 0.2 to 3.0 GHz range. The coupling ratio may be calibrated to an accuracy of better than $\pm$0.15 db (using a suitable instrument such as the AIL Type 137 Receiver), thus allowing the Signal Source to be converted into an accurate generator of RF power if a power monitor is connected to the SAMPLE R. F. OUTPUT.

11. RELATIVE POWER METER

A diode detector, in conjunction with the directional coupler, samples the RF power to the load and converts it to a DC current that is read out on the RELATIVE POWER meter. Since the coupler and detector are frequency-sensitive, a direct power calibration would be misleading. However, for matched-load conditions at any given frequency, an increase in the reading of the RELATIVE POWER meter will indicate an increase in power to the load. In addition, as noted in paragraph G.4 of Section 4, the meter may be used as an absolute power meter for power levels exceeding 10 watts, and frequencies below 1.5 GHz.

B. SQUARE-WAVE GENERATOR

The Power Signal Source contains a multivibrator (V101) that can be used to 100-percent modulate the RF oscillator with either a 400- or a 1000-Hz square-wave signal. The frequency of the multivibrator may be adjusted at least $\pm$10 percent by means of the INT.

MOD. FREQ control. This multivibrator is turned on by the MODULATION selector switch. A symmetry control is provided to allow the on and off periods of the square wave to be equalized.

C. MODULATION

The Power Signal Source can be grid-modulated with a variety of waveforms. The type of modulation is selected by the setting of the MODULATION selector switch on the front panel. Peak power in all modulation modes usually equals, or exceeds, that of the CW power available at the particular frequency.

1. INTERNAL MODULATION

Full square-wave modulation is provided when the MODULATION selector switch is set to INT. 400⊓⊔ or INT. 1000⊓⊔. Grid modulation of the RF tube is accomplished by means of modulation power amplifier V103 and transformer T103.

2. CW

The Power Signal Source will operate unmodulated to furnish CW oscillation when the MODULATION selector switch is set to CW.

3. EXTERNAL AMPLITUDE MODULATION

With the MODULATION selector switch set to EXT. A. M. and a 3-volt rms generator connected to the A. M. INPUT jack, the Power Signal Source can be 100-percent square-wave modulated, and 10-percent sine-wave modulated, at frequencies from 300 Hz to 10 kHz. Amplitude modulation at frequencies as low as 100 Hz and as high as 100 kHz is possible with a reduced modulation percentage and increased distortion. The input impedance is 10 kilohms. The LEVEL SET control adjusts the signal level into EXT. A. M. amplifier V102. Additional power gain is provided by modulation power amplifier V103, which feeds transformer T103 to effect grid-modulation of RF tube V104.

4. EXTERNAL PULSE MODULATION

With the MODULATION selector switch set to EXT. PULSE and a source of 25-volt peak pulses connected to the panel terminal marked PULSE INPUT, the Power Signal Source can be essentially 100-percent modulated for pulse widths of 0.5 to 25 microseconds and for duty cycles up to 5 percent. When the MODULATION selector switch is set to EXT.PULSE, the connections to V103 are changed to make it a conventional pulse modulator. Between pulses, C109 and C110 are charged through R120. During this period, modulator tube V103 is biased near cutoff. The oscillator is also biased by means of cathode resistor R121. When the modulator is triggered, C109 and C110 are effectively placed between the RF tube cathode and ground, reducing the cathode bias and permitting the tube to oscillate.

For a given value of Q for the cavity, pulse rise and fall times are inversely proportional to the Signal Source frequency. Thus, rise times may be as large as 1.5 microseconds at 0.2 GHz and drop down to less than 0.1 microsecond at 2.0 GHz. Fall times, in general, are twice as long as rise times. See Figure 2-6 for typical values of rise and fall times versus Signal Source frequency.

At frequencies below 1.5 GHz, it may be found that some CW oscillation occurs between pulses. This residual CW level should be typically 40 db below the pulse power level on the LOW range, 50 db below on the MID range, and 60 db below on the HIGH range.

D. POWER SUPPLY

1. HIGH VOLTAGE

The high-voltage power supply consists of one winding (leads 5 and 6) on power transformer T101, a full-wave bridge rectifier, an associated filter choke L101, and capacitors C116 and C117. It is regulated to ±1 percent against ±10 percent line variations. This circuit supplies 1200 volts, via the R. F. OUTPUT ATTENUATOR section, to RF tube V104. By means of resistor R120, about 600 volts is sup-

plied to modulation power amplifier V103 in the EXT.PULSE, EXT. A.M., and INT. 1000⊓⊔, and INT. 400⊓⊔ modes of operation.

2. LOW VOLTAGE

The low-voltage power supply consists of one winding (leads 7 and 8) on power transformer T101, full-wave bridge rectifier CR105 to CR108, an associated filter choke L102, and capacitors C118 and C119. It is regulated to ±1 percent against ±10 percent line variations. This circuit supplies 350 volts to multivibrator V101 during the INT. 1000⊓⊔ and the INT. 400⊓⊔ modes of operation. During the EXT.A.M. and EXT.PULSE modes of operation, the bleeder resistors R137 and R138 reduce the voltage supplied to V102 to about 300 volts; in addition, the resistors also provide a negative bias of about 50 volts to modulation power amplifier V103 to optimize its pulse performance.

3. FILAMENT

The filament supply consists of transformer T102. All tube filaments derive 6.3 volts rms from its secondary, except the RF tube V104. The latter's filament voltage is approximately 5.6 volts rms, due to the 0.68-ohm series resistor used. The lower voltage substantially improves the lifetime of the RF tube.

4. FUSES

Three of the four fuses used are of the "S1o-B1o" type, to allow for the possibility of high transient currents during improper tuning. The fuse current values, however, have been chosen so as to blow before any permanent damage is done to RF tube V104 or any other circuitry. A normal blow fuse (F104) is used in series with the Amperite ballast tube, since the latter is easily damaged by transients caused by incorrect operating procedures. Two replacement fuses for F104 are stored on the rear panel.

E. ATTENUATORS

1. FIXED

The SAMPLE R. F. OUTPUT provides a fixed attenuation of 30 ±3 db over the entire 0.2 to 3.0 GHz frequency range (refer to paragraph A.10 of this section). A LOAD MUST STILL BE CONNECTED TO THE MAIN R. F. OUTPUT WHEN THE SAMPLE R. F. OUTPUT IS USED.

2. VARIABLE

The R. F. OUTPUT ATTENUATOR R123 enables continuous attenuation of greater than 30 db of the power output of either the R. F. OUTPUT or the SAMPLE R. F. OUTPUT over most of the 0.2 to 3.0 GHz frequency range. The section consists of two, sequence-coupled rheostats which serve to vary the plate voltage of the RF tube, the power output being nonlinearly proportional to plate voltage. This method of attenuation keeps RF leakage at a constant, low percentage regardless of the power output setting.

The R. F. OUTPUT ATTENUATOR will have a greater variable attenuation range at lower frequencies than at higher frequencies (for example, about 60-db range at 0.2 GHz) due to transit-time effects. Plate voltages as low as 80 volts will permit operation at 0.2 GHz versus minimum plate voltages of 600 volts required for the RF tube at 3.0 GHz.

The Power Signal Source frequency shift is typically less than 0.25 percent when the R. F. OUTPUT ATTENUATOR is varied over its full range. This shift can be easily compensated for by a slight adjustment in the position of the PLATE TUNING control. Frequency shift may be as great as 1 percent in the frequency region above 2.0 GHz.

Power resettability of the order of 0.2 db can be achieved if the Signal Source tuning is optimized when the R. F. OUTPUT ATTENUATOR is varied back and forth.

SECTION 6
MAINTENANCE

A. GENERAL

Except for lubrication of the blower motors, no special maintenance is required on the equipment. Before starting the motors, add four drops of light motor oil to each of the oil wells. Lubricate the motors every 3 months, or more often if ambient conditions require it.

When trouble occurs in the Power Signal Source, isolate it to a specific circuit by using normal servicing techniques. Trouble in the modulation stages (V101, V102, and V103) may be traced by using the appropriate voltage and resistance tables found in this section. Trouble in the RF stage (V104) is best traced using a resistance check (see Figure 7-4 for the schematic). After a defective part is repaired and/or replaced, the portion of the equipment that is affected should be thoroughly rechecked visually, mechanically, and electrically, to verify the proper operating condition of the component. Note that there is a power interlock on the back panel which must be depressed, or shorted, for checking the instrument with the back panel door open.

WARNING

This equipment uses high voltages that can be fatal if contacted. Extreme caution must be exercised when working on the equipment.

Figure 6-1 shows a top view of the Power Signal Source as to component locations and Figure 6-2 shows a bottom view of the Signal Source as to component locations. Figure 6-3 shows the printed circuit board assembly.

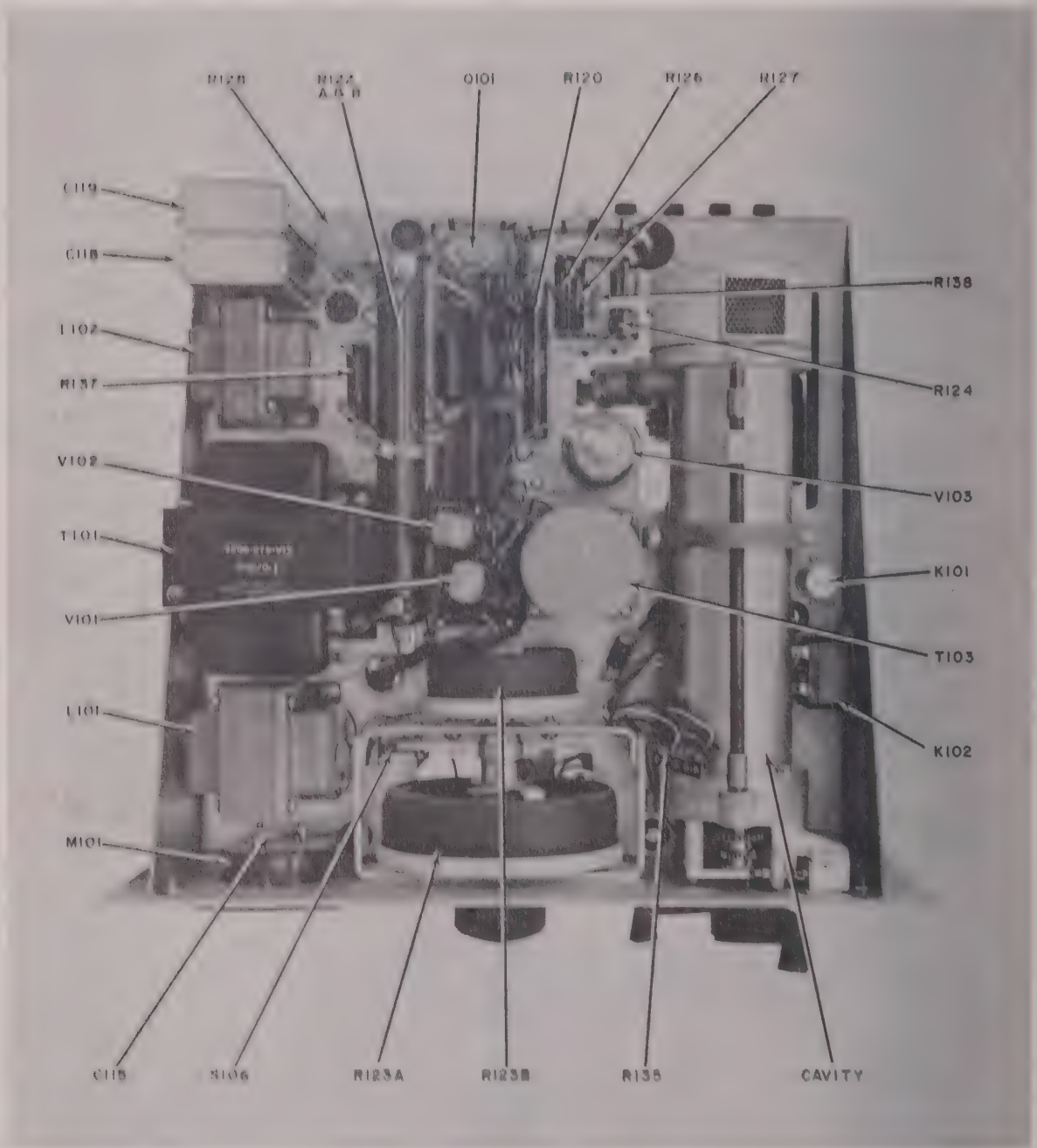


FIGURE 6-1. TOP VIEW OF SIGNAL SOURCE CHASSIS

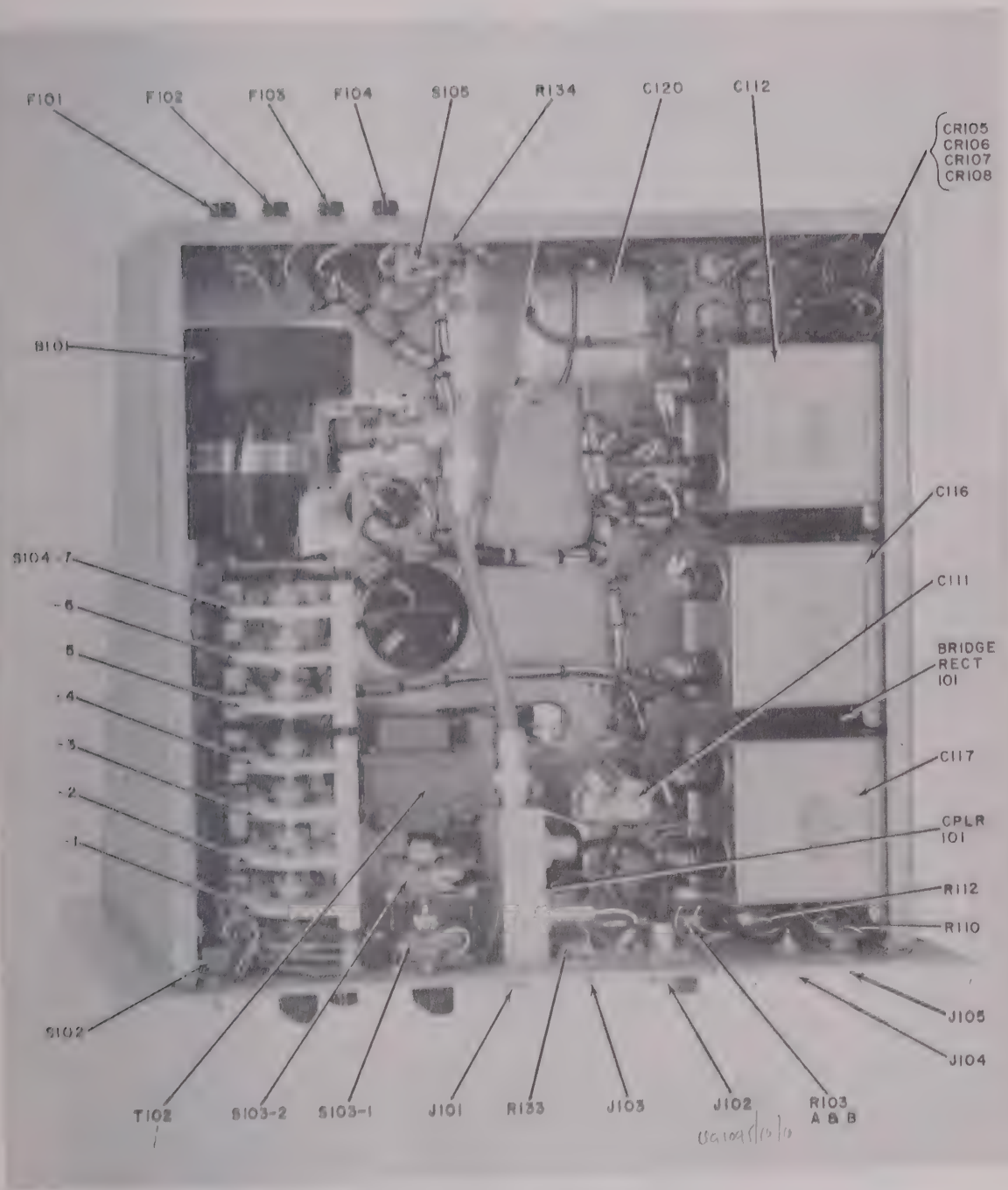


FIGURE 6-2. BOTTOM VIEW OF SIGNAL SOURCE CHASSIS

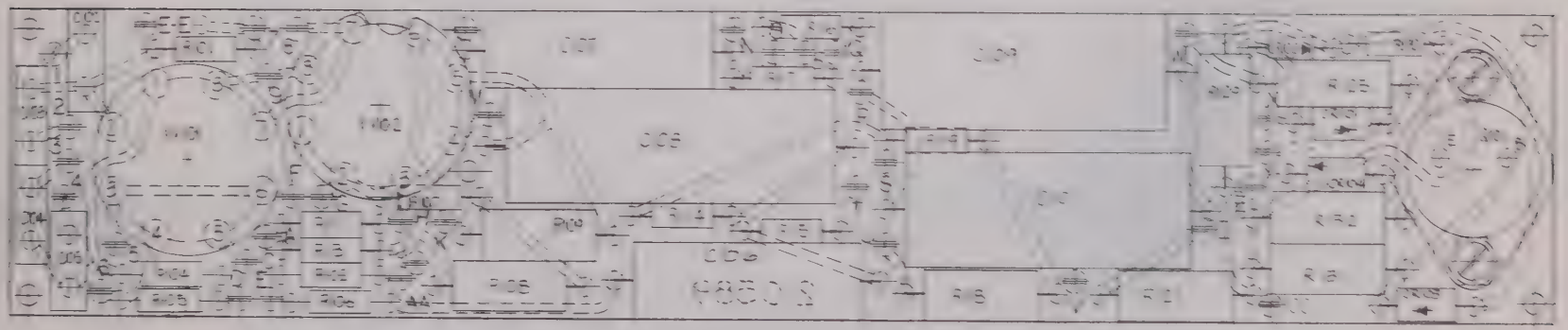


FIGURE 6-3. PRINTED CIRCUIT BOARD ASSEMBLY

B. TROUBLE ANALYSIS OF SIGNAL SOURCE

The unique, four-octave frequency capability of the Power Signal Source required special techniques in mechanical and electrical design. All of these techniques should result in trouble-free performance for many years of operation. However, some areas of operation are susceptible to operator error. These areas should be checked first when looking for the cause of low power output, or erratic operation, or large deviation from the specified counter settings.

TABLE 6-1

TROUBLE ANALYSIS--POWER SIGNAL SOURCE

Probable Trouble	Remedy
F104 blown	Replace. Refer again to paragraphs B, C, D, and E of Section 4 for the correct tune-up procedure
Cathode--loading element either missing on LOW range, or left in on MID and HIGH range; wrong feedback assembly being used; coupling loop either all the way out when it should be all the way in, or vice versa.	Refer to paragraph A of Section 4 for the correct assemblies to be used on each range
Feedback assembly capacitive tab, or inductive loop damaged	Repair or replace. Refer again to the caution notes in paragraph A. 1, steps e and h, and paragraph A. 2, steps e and k, of Section 4

Some less frequent troubles which may explain low power output, or erratic operation, or large deviation from the specified counter settings are:

Probable Trouble	Remedy
Coupling not optimum	Increase or decrease COUPLING setting to peak the RELATIVE POWER meter in CW-mode, or obtain best wave shape in any other modulation mode with the R. F. OUTPUT ATTENUATOR set to at least 50 (LOW or MID ranges); or at least 25 (HIGH range)
Ballast resistor R128 blown	Replace and check that the fuseholder for F104 has a normal-blow, 1 ampere fuse in it. Refer again to paragraphs B, C, D, and E of Section 4 for the correct tune-up procedure
RF tube V104 not seated properly in cavity; weak RF tube	To properly contact the four sets of spring contacts (filament, cathode, grid, and anode) in the cavity, the RF tube must be pushed into the cavity as far as it can go. A slight clockwise rotation will aid in the proper seating of the tube. To replace a weak RF tube, see paragraph C of this section

To confirm the presence of a poor modulation wave shape, connect a coaxial crystal detector to the R. F. SAMPLE OUTPUT and check the wave shape at that output. If it is much better in appearance, relative to the wave shape from the MOD. MONITOR OUTPUT, check for the following:

Probable Trouble	Remedy
R134 loading MOD. MONITOR OUTPUT too much	Increase the resistance of R134 by turning the back-panel control clockwise
Diode mounting cap on Coupler 101 is loose, shorted, or open	Tighten, or resolder. Be careful not to omit the small resistive cylinder in the diode mounting cap
Diode detector is defective or internal resistor is broken	Replace 1N21 diode if necessary. Loosen two Allen-head setscrews holding detector mount in place and replace resistor if necessary

If the modulation wave shape is poor at both the MOD. MONITOR OUTPUT and detected R. F. SAMPLE OUTPUT, and your front panel connections and switches are in the proper positions, check for the following:

Probable Trouble	Remedy
F103 blown	Replace. Refer again to paragraphs B, C, D, and E of Section 4 for the correct tune-up procedure
V103 defective	Replace
V102 defective	Replace
V101 defective	Replace

C. REPLACEMENT OF RF TUBE

To replace RF tube V104 in the cavity unit, proceed as follows:

1. Remove the metal end plate from the rear of the cavity unit by unscrewing the four, red thumbscrews.
2. Grasp the defective tube by the cooling fins and pull it out, using a clockwise twisting motion to loosen the tube from the contact springs.
3. Grasp the new tube by the cooling fins and gently press-fit the tube into the cavity unit as far as it will possibly go, using a clockwise twisting motion. Optimum tube cooling results when the slots in the tube radiator are aligned parallel to the air flow.
4. Replace the end plate at the rear of the cavity unit and tighten the thumbscrews.

Tube replacement degrades the accuracy noted in the front panel frequency card by less than 0.25 percent, typically.

The special AIL tube (P/N 211310) is the preferred replacement; however, any type of 7289 will work well except for poorer stability and lifetime. Tubes such as the 2C39B and the 6897 will meet most specifications up to 2.6 GHz. The 2C39A will provide typically

2 db less power output across the entire frequency band, but otherwise, it will perform well. The 7815 meets most specifications in the MID and HIGH ranges, but will not oscillate in the LOW range because of construction differences. In general, the special AIL tube will give two to four times better lifetime and stability than the other tubes mentioned.

D. REPLACEMENT OF OTHER COMPONENTS

The removal and replacement of other components can be accomplished using routine techniques associated with the maintenance of electronic equipment. In most instances, the chassis will have to be removed from the cabinet. This may be accomplished in the following manner:

1. Disconnect primary AC power from the unit.
2. Remove the four front panel screws.
3. Disconnect the two brackets at the rear of the chassis from the cabinet.
4. Disconnect the rear panel cooling fan by removing the molded plug on the lower portion of the fan assembly, and removing the cable from the two clamps holding it in place.
5. Push the chassis from the rear so that the front panel will extend beyond the cabinet bezel.
6. Slide the unit out of the cabinet.

E. DEPTH SETTING OF FEEDBACK ASSEMBLY

If the factory-set positioning screw (sealed with glyptal) has become loose, a resetting is necessary. For the MID-frequency feedback assembly (0.3 to 1.0 GHz) or the HIGH-frequency feedback assembly (0.9 to 3.0 GHz), proceed as follows:

1. Remove the hat assembly of the cavity and retract the coupling probe and coupling loop all the way out.

2. Retract the three, red-dotted, Allen-head set-screws on the feedback assembly, and screw the feedback assembly into place on the cylinder using the U-shaped extractor.

3. Rotate the feedback assembly until its back surface is 3/8 + 1/32 inch from the hat assembly mounting surface, and its position is such that two of the protruding tabs (or loops in the case of the HIGH frequency assembly) are equally spaced on either side of the coupling probe.

4. After the feedback assembly has been correctly positioned, tighten the positioning screw until it contacts the end of the cylinder.

5. Carefully remove the feedback assembly, making sure that the positioning-screw setting is not disturbed.

6. Seal this setting with a drop of glyptal.

For the LOW-frequency feedback assembly (0.2 to 0.6 GHz), whose configuration is different than the other feedback assemblies, the setting of the positioning screw is as follows:

1. Push the cathode-loading element into the cathode cylinder, closed-end first, until the inner hub face of the element is aligned with the shoulder under the hexagonal nut at the end of the cathode cylinder.

2. Retract the three, red-dotted, Allen-head set-screws on the feedback assembly.

3. Carefully determine where the threads engage the cylinder, mount the feedback assembly, and turn it clockwise 4-1/3 turns. The tabs should be positioned equally on both sides of the coupling probe.

4. Replace the hat assembly RF tube, and the end plate.

5. Connect the RF output to a suitable 50-ohm load.

6. Set the PLATE counter to 00000 and the CATHODE counter to 00500.

7. Turn on the power and allow the equipment to warm up for 10 minutes at full RF power output.

8. Determine the operating frequency of the oscillator with a frequency meter. If the frequency is from 0.195 to 0.202 GHz, the feedback assembly is correctly positioned. If the frequency is below 0.195 GHz, reposition the feedback assembly by rotating it clockwise an additional 1/3-turn. If the oscillator falls outside the acceptable 0.195 to 0.202 GHz range, resetting of the feedback assembly slightly in either direction should be attempted. In no case should the assembly be positioned so that there is a possibility of the tabs interfering with the coupling probe.

9. When the correct position of the feedback assembly has been determined, tighten the positioning Allen-head setscrew until it contacts the end of the cylinder.

10. Carefully remove the feedback assembly without disturbing the setscrew setting. Seal this setting with a drop of glyptal.

F. COUNTER CALIBRATION

If the cavity is removed from the instrument and the PLATE and CATHODE counters have been disturbed, a recalibration will be necessary to maintain the usefulness of the average tuning curves (Figures 7-1, 7-2, and 7-3) and the front-panel frequency card.

The PLATE and CATHODE counters are set as follows:

1. Rotate the tuning knob counterclockwise until both plate and cathode plungers reach their mechanical stops.

2. Disengage each counter and rotate the numbers toward 00000. Set the counter five numbers below zero (that is, at 99995); then reengage the counter. With the Signal Source operating in the CW mode, check that the indicated counter reading for a particular frequency of operation agrees with the front panel frequency card to within ± 1 percent (extra cards are provided on the back panel in case a new calibration is needed).

G. NOMINAL VOLTAGES AND RESISTANCES

The following nominal voltages and resistances are typical for an operating unit. They were made using a VTVM.

TABLE 6-2
RESISTANCE MEASUREMENTS FOR V101, V102, AND V103

	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
INT. 1000Ω								
(6SN7) V101	1.0 M	83 K	2.2 K	1.0 M	83 K	2.2 K	640	640
(6SN7) V102	100	51 K	3.3 K	10 K	57 K	200	640	640
(807) V103	640	50 K	293 K	950	640	(CAP) 47K	---	---
CW								
V101	1.0 M	81 K	OPEN	1.0 M	OPEN	OPEN	OPEN	OPEN
V102	100	33 K	3.3 K	10 K	40 K	200	OPEN	OPEN
V103	OPEN	OPEN	1.1 M	750 K	OPEN	(CAP) OPEN	---	---
EXT. PULSE								
V101	1.0 M	79 K	OPEN	1.0 M	OPEN	OPEN	1 K	1 K
V102	100	15 K	3.3 K	10 K	22 K	200	1 K	1 K
V103	1 K	49 K	273 K	0	1 K	(CAP) 46 K	---	---
EXT. A.M.								
V101	1.0 M	79 K	OPEN	1.0 M	OPEN	OPEN	640	640
V102	100	15 K	3.3 K	10 K	22 K	200	640	640
V103	640	50 K	293 K	950	640	(CAP) 47 K	---	---

Notes:

1. All measurements are made with the VTVM and are referenced to chassis ground.
2. Unit-to-unit variation from nominal values may be ±25 percent.
3. The INT. MOD. FREQ. knob is set to full clockwise position.
4. The LEVEL SET knob is set to full clockwise position.
5. The FREQ. RANGE switch is set to MID position.
6. The R. F. OUTPUT ATTENUATOR knob is set to full clockwise position.

TABLE 6-3

VOLTAGE MEASUREMENTS FOR V101, V102, AND V103
(Referenced to Chassis Ground)

	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
INT. 1000 Ω								
(6SN7) V101	-50	75	-45	-75	65	-45	FIL.	FIL.
(6SN7) V102	0	-15	0	0	-20	0	FIL.	FIL.
(807) V103	FIL.	600	-45	18	FIL.	Note (2)	---	---
CW								
V101	260	290	290	260	0	290	FIL.	FIL.
V102	0	48	2	0	33	1	FIL.	FIL.
V103	FIL.	0	0	0	FIL.	Note (2)	---	---
EXT. PULSE								
V101	235	260	260	235	0	260	FIL.	FIL.
V102	0	250	10	0	160	3	FIL.	FIL.
V103	FIL.	650	-68	0	FIL.	Note (2)	---	---
EXT. A.M.								
V101	235	260	260	235	0	260	FIL.	FIL.
V102	0	250	10	0	160	3	FIL.	FIL.
V103	FIL.	325	0	21	FIL.	Note (2)	---	---

Notes:

1. RF Tube (V104) is removed from its socket.
2. Voltage on 807 plate cap is approximately 0 to 15 volts greater than the voltage on its screen (pin 2).
3. The INT. MOD. FREQ. knob is set to full clockwise position.
4. The SYMMETRY knob is set to full clockwise position.
5. No input to EXT. PULSE and EXT. A.M. positions.
6. Unit-to-unit variation from nominal values may be ±25 percent.

TABLE 6-4

REPLACEABLE PARTS
(Refer to Figures 6-1, 6-2, and 6-3)

Symbol	Description	Manufacturer	Part No.
Blowers			
B101	Cavity blower, 30 cfm, 115 V, 50-60 Hz	Ripley	SU-2700
B102	Chassis blower, 100 cfm, 115 V, 50-60 Hz	Rotron	SKR4
Capacitors			
C101	5000 pf, ceramic, 500 V, ±10%	Sprague	4TM-P10
C102	2400 pf, mica, 500 V, ±5%	Elmenco	DM-19-242J
C103	1000 pf, mica, 500 V, ±5%	Elmenco	DM-19-102J
C104	Same as C103		
C105	Same as C102		
C106	0.1 μf, mylar-paper, 400 V, ±10%	Sprague	4TM-P10
C107	Same as C106		
C108	0.47 μf, mylar-paper, 400 V, ±10%	Sprague	4TM-P47
C109	0.068 μf, mylar-paper, 1600 V, ±10%	Mallory	GEM 16168
C110	Same as C109		
C111	0.5 μf, oil, 2000 V, ±10%	Cornell-Dubilier	TJH-20005
C112	4 μf, oil, 2000 V, ±10%	Cornell-Dubilier	TJU-20040
C113	Oscillator cathode bypass capacitor within oscillator assembly	AIL	113523
C114	Oscillator plate bypass capacitor within oscillator assembly	AIL	113488

TABLE 6-4 (cont)

Symbol	Description	Manufacturer	Part No.
C115	5000 pf, mica, 500 V, ±10%	Centralab	CF502
C116	Same as C112		
C117	Same as C112		
C118	6 μf, oil, 600 V, ±10%	Cornell-Dubilier	TJH-6060
C119	Same as C118		
C120	4 μf, oil, 660 V, ±10%	General Electric	6411-600Y 49F4343
C121	15 μf, aluminum, 25 WVDC	Cornell-Dubilier	NLW 15-25
Semiconductors			
BR101	Bridge rectifier	Semtech	SA1244
CR102	Diode rectifier	Semtech	SC20E
CR101 and all other diodes	1N2071		
Q101	2N1022A		
Fuses (all S1o-B1o, except F104)			
F101 and F102	Line fuses, 5 amp, 3AG	Littelfuse	313-005
F103	Plate power fuse, 175 ma, 3AG	Littelfuse	313-175
F104	Ballast tube fuse, 1.0 amp, 3AG	Littelfuse	312-001
Receptacles			
J101	Jack	AIL	210524
J102	Same as J101		
J103 through J105	Jack		UG-625 B/U
J106	Type N, right-angle adaptor	Amphenol-Borg	UG-27 C/U
J107	Chassis-blower disconnect	Rotron	18944

TABLE 6-4 (cont)

Symbol	Description	Manufacturer	Part No.
Chokes			
L101	Filter choke, 10 h, 200 ma	Freed	28650
L102	Filter choke, 30 h, 100 ma	Freed	28651
Resistors			
R101	68 k, carbon, 1/2 w, 5%		RC20GF683J
R102	Same as R101		
R103	200 k/250 k, dual-potentiometer, 2 w, 20%	AIL	115289-18
R104	1 Meg, carbon, 1/2 w, 5%		RC20GF105J
R105	Same as R104		
R106	Same as R101		
R107	3.3 k, carbon, 1/2 w, 5%		RC20GF332J
R108	47 k, carbon, 2 w, 5%		RC42GF473J
R109	10 k, carbon, 2 w, 5%		RC42GF103J
R110	100 ohms, carbon, 2 w, 5%		RC42GF101J
R111	Same as R107		
R112	10 k, potentiometer, 2 w, 5%	AIL	115289-16
R113	200 ohms, carbon, 1/2 w, 5%		RC20GF201J
R114	270 k, carbon, 1/2 w, 5%		RC20GF274J
R115	470 k, carbon, 1/2 w, 5%		RC20GF471J
R116	Same as R110		
R117	Same as R107		
R118	400 ohms, wirewound, 5 w, 5%	Ohmite	995-5B
R119	22 k, carbon, 1/2 w, 5%		RC20GF223J

TABLE 6-4 (cont)

Symbol	Description	Manufacturer	Part No.
R120	15 k, wirewound, 50 w, 5%	Ohmite	0416
R121	1 k, carbon, 2 w, 5%		RC42GF102J
R122	2.5 k, wirewound, adjustable, 160 w, 5%	Ohmite	1163
R123	30 k/50 k, rheostats, 300 w/150 w	AIL	210940
R124	400 ohms, wirewound, 12 w, 5%	Ohmite	"Brown Devil"
R125	Same as R110		
R126	Same as R124		
R127	Same as R124		
R128	Ballast tube, 210 ma, 5%	Amperite	2A20
R129	5.1 k, carbon, 2 w, 5%		RC42GF512J
R130	11 ohms, carbon, 1/2 w, 5%		RC20GF110J
R131	2.7 k, carbon, 2 w, 5%		RC42GF272J
R132	Same as R110		
R133	680 ohms, carbon, 1/2 w, 5%		RC20GF681J
R134	10 k, potentiometer, 2 w, 20%	Allen-Bradley	JLU-1031
R135	0.68 ohm, wirewound, 2 w, 10%	IRC	BWH
R136	330 ohms, carbon, 2 w, 5%	Allen-Bradley	RC42GF331J
R137	15 k, wirewound, 25 w, 5%	Ohmite	0217
R138	2.2 k, wirewound, 5 w, 5%	Ohmite	"Brown Devil"
R139	Same as R119		
R140	750 k, carbon, 1/2 w, 5%		RC20GF754J
R141	150 ohms, wirewound, 5 w, 5%	Ohmite	"Brown Devil"

TABLE 6-4 (cont)

Symbol	Description	Manufacturer	Part No.
Switches			
S101	Tapswitch, SPST	Cutler-Hammer	8282K14
S102	Toggle switch, DPDT	Cutler-Hammer	8370K7
S103	Frequency range switch	AIL	209117
S104	Modulation selector switch	AIL	210518
S105	Power interlock switch	Micro-Switch	1DM21
S106	"+100" indicator switch	Honeywell	V3L-2-D8
K101	Time delay switch	G. V. Controls	115N090T
K102	Power-line relay switch	Essex Wire	84-903
Transformers			
T101	Power transformer	Acme Electric	T-57255
T102	Filament transformer	AIL	113713-2
T103	Modulation transformer	UTC	CG-710
Tubes			
V101	6SN7		
V102	Same as V101		
V103	807		
V104	RF Tube	AIL	211310
Miscellaneous			
CPLR 101	Directional coupler	AIL	210524
I101	Neon lamp		NE51H
I102	Indicator light		
M101	Relative power meter	AIL	209116
FIL 101	RF filter	Erie	CSK711
	Printed circuit board	AIL	210589

SECTION 7
TUNING CURVES AND SCHEMATIC

Figures 7-1 through 7-3 show the average tuning curves for the LOW-, MID-, and HIGH-frequency ranges of the Power Signal Source. Figure 7-4 shows the Signal Source schematic.

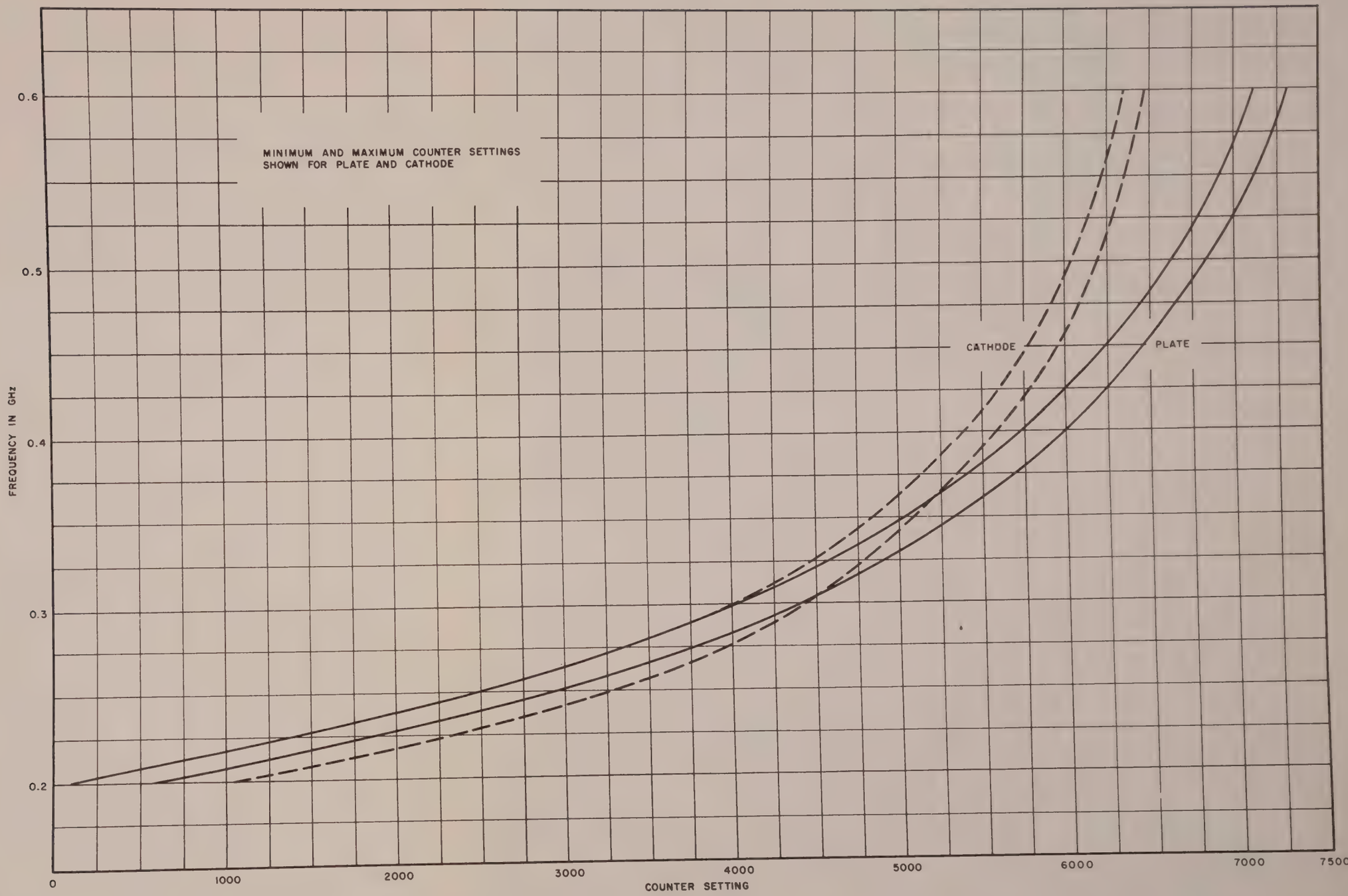


FIGURE 7-1. AVERAGE TUNING CURVES FOR LOW RANGE

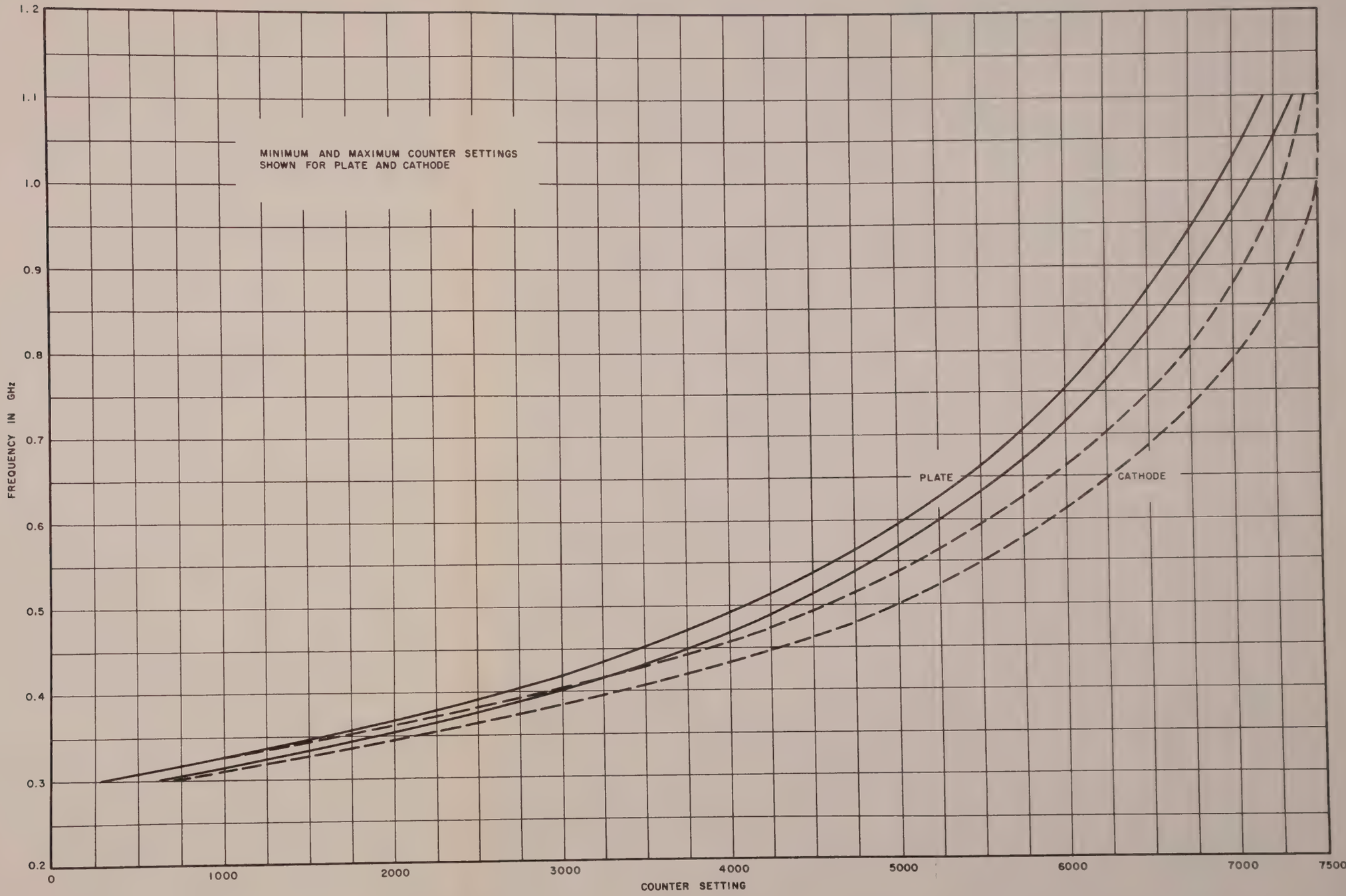


FIGURE 7-2. AVERAGE TUNING CURVES FOR MID RANGE

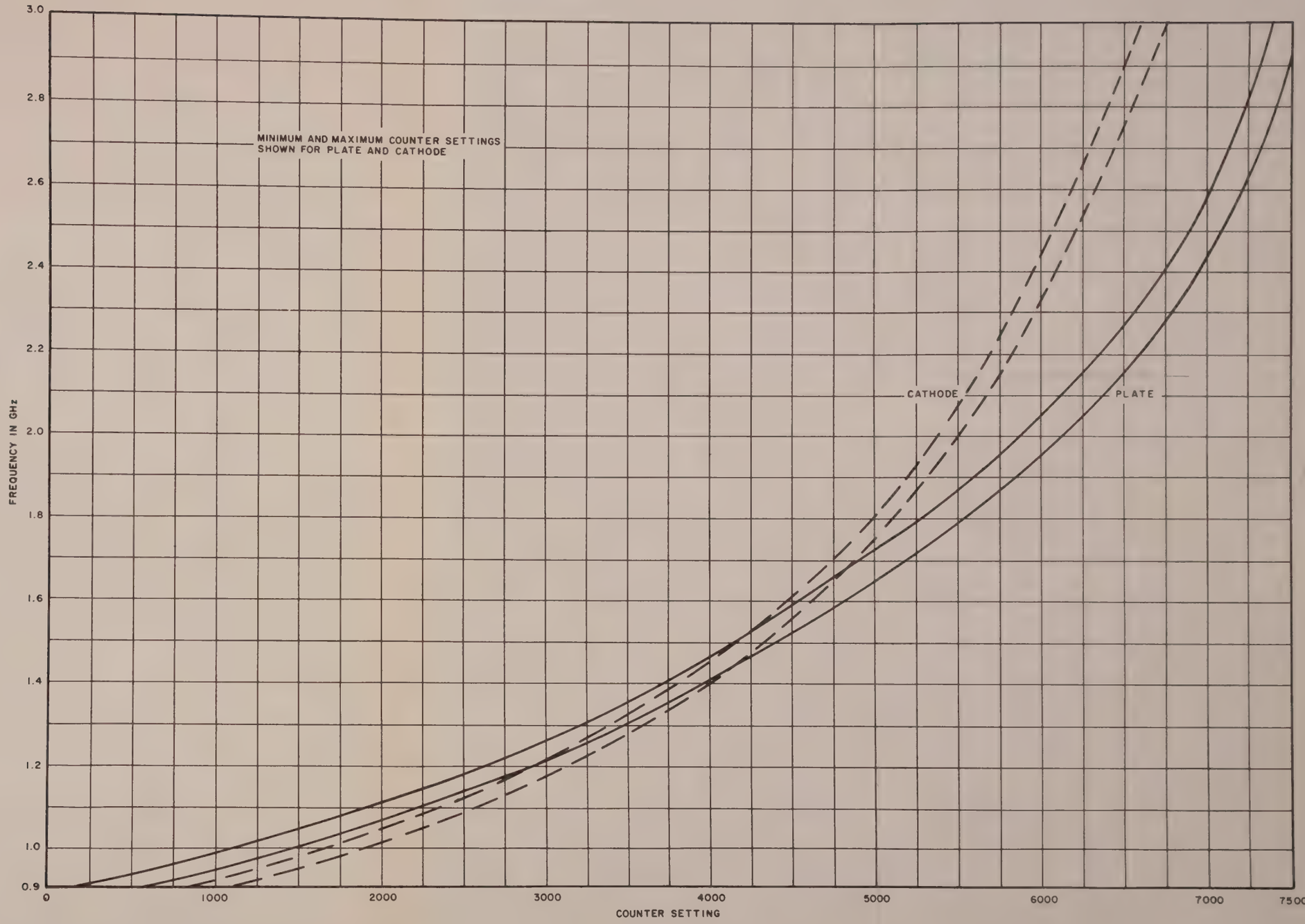
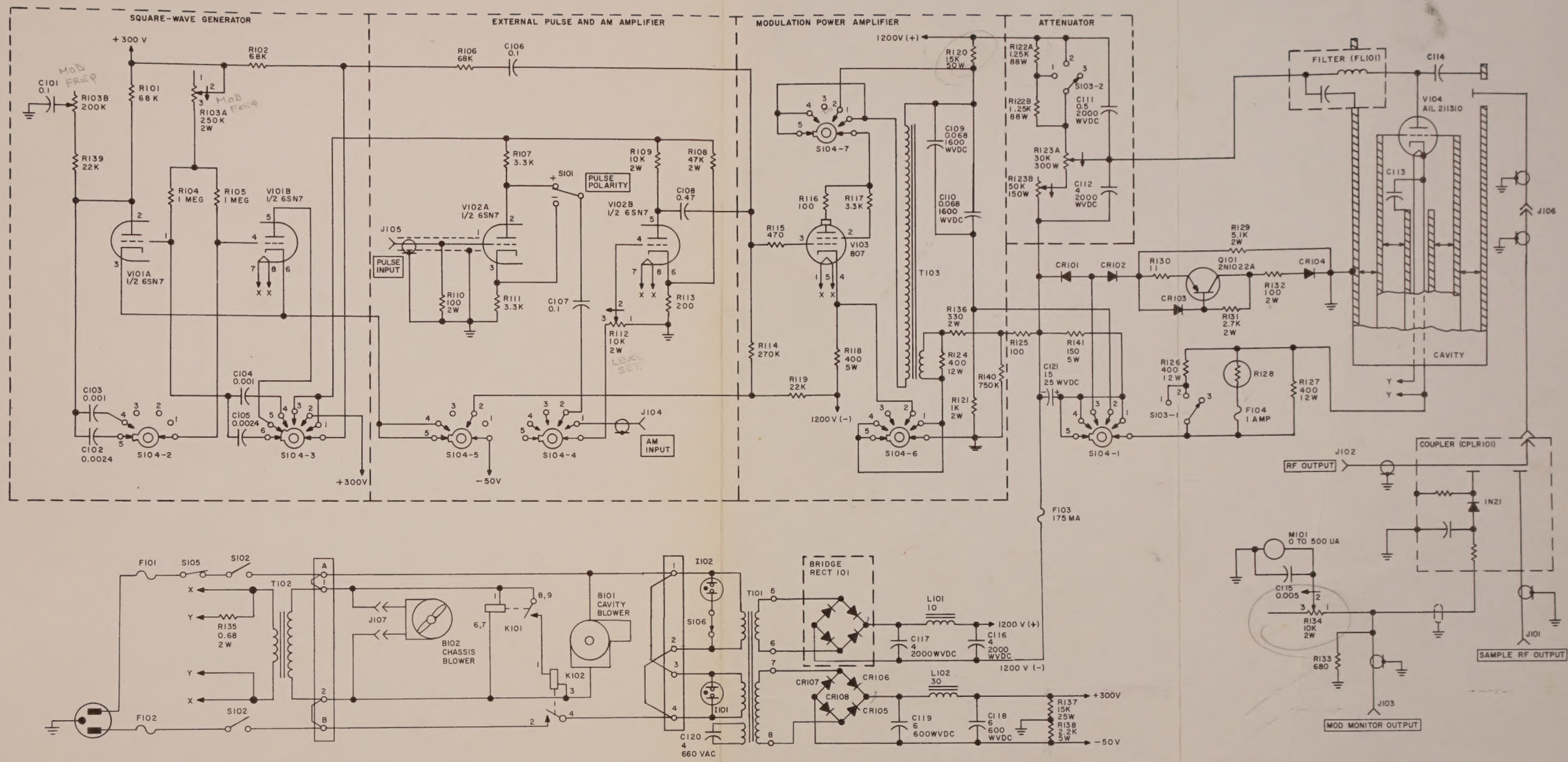


FIGURE 7-3. AVERAGE TUNING CURVES FOR HIGH RANGE



SWITCH FUNCTIONS:

S101: PULSE POLARITY
S102: POWER
S103: FREQUENCY RANGE SWITCH
1. LOW RANGE
2. MID RANGE
3. HIGH RANGE

S104: MODULATION
1. EXT. A.M.
2. EXT. PULSE
3. CW
4. INT. 1000 ⎍⎍
5. INT. 400 ⎍⎍
S105: POWER INTERLOCK
S106: "+100" INDICATOR

SWITCH POSITIONS SHOWN:

S101: POSITIVE PULSE IN
S102: POWER OFF
S103: HIGH RANGE
S104: INT. 400 ⎍⎍
S105: REAR PANEL CLOSED
S106: "+100" ON

POTENTIOMETER FUNCTIONS

R103A INT. MOD. FREQ. ADJ.
R103B INT. MOD. FREQ. SYMMETRY ADJ.
R112 EXT. MOD. LEVEL SET
R123 R.F. OUTPUT ATTENUATOR
R134 RELATIVE POWER METER

INDICATOR FUNCTIONS

I101: POWER
I102: R.F. OUTPUT ATTENUATOR "+100".

UNLESS OTHERWISE NOTED:

RESISTANCE VALUES IN OHMS, ±5%, 1/2 WATT
CAPACITANCE VALUES IN UF; ALL VOLTAGES ARE AT LEAST 400 WVDC.
INDUCTANCE VALUES IN HENRIES
DIODES ARE TYPE 1N2071 EXCEPT FOR CR102

FIGURE 7-4. SIGNAL SOURCE SCHEMATIC

Bil Sekon.

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